ANNALS

OF

The Entomological Society of America

Volume V DECEMBER, 1912 Number 4

THE NORTH AMERICAN DIGGER WASPS OF THE SUBFAMILY SCOLIINAE.*

OSCAR C. BARTLETT, B. Sc.

INTRODUCTION.

This contribution to our knowledge of the sub-family Scoliinæ (digger wasps) found in North America, Central America and the West Indies, is the result of work done at the Massachusetts Agricultural College under the direct supervision of Doctor H. T. Fernald, and forms a portion of a thesis for the degree of doctor of philosophy. In it, an attempt has been made to place before those interested, a paper in which our present knowledge of these wasps is systematically arranged and the identification of the species facilitated.

There are given here the descriptions of nineteen species and two genera, while four unknown species and one unidentified subspecies are listed at the end. Of the above mentioned species three are new. The type of each genus has been given in the historical sketch and so far as is known, the location of all the types has been stated in each specific description. Whenever the writer thought it necessary, translations from the original descriptions or direct copies have been made. In each case full credit has been given to the original writer.

Several workers have published descriptions of members of this subfamily in various publications and many have from one to several references to the group, showing the scattered character of the information. Works which the writer has found most important are: Saussure and Sichel, Catalogus Specierum Generis Scolia, 1864; Burmeister, Bemerkungen über Bau u. Gesechlechtsunterscheide Gattung Scolia, Abh. Nat. Gesell. Halle, 1854; Saussure, Desc. esp. nouv. Scolia, Ann.

*A portion of a thesis for the degree of Doctor of Philosophy at the Massachusetts Agricultural College.

Ent. Soc. France, (3), 1858; Saussure, Quelques Scolies de Basse-Californie, Ann. Ent. Soc. France, (4), 1863; Cresson's descriptions in the Proceedings of the Entomological Society of Philadelphia and in the Transactions of the American Entomological Society; Cameron's descriptions in the Biologia Centrali-Americana; the writings of Say, and the Catalogue of the Hymenoptera of the British Museum by F. Smith.

All terms used are fully explained in Smith's Glossary of Entomology. Cresson's system of nomenclature for the wing venation is used.

I am under many obligations to those who have assisted me in making this paper more complete, either by lending specimens to Professor H. T. Fernald that I might use them for study, or by giving me counsel at times when such was needed, especially Dr. Guy C. Crampton, S. A. Rohwer of the National Museum, E. T. Cresson, Jr.; and to Dr. H. Skinner for the privilege of study at the American Entomological Society at Philadelphia. I wish to thank Mr. W. S. Regan who so kindly spent valuable time while studying at New York, Brooklyn, Philadelphia and Washington, in securing for me material to work upon. It was my good fortune to have studied a part of the time under Professor Charles H. Fernald whose aid and assistance I greatly appreciate.

To Doctor H. T. Fernald I wish to express my gratitude for the many ways he has encouraged and guided me in my work and for the aid so willingly given at all times.

COLLECTIONS.

The work in this paper is based upon the collections of the National Museum together with the collections made by members of the Bureau of Entomology in Texas in connection with the Southern Field Crop investigations directed by W. D. Hunter; and the excellent collection at the American Entomological Society at Philadelphia. The American Museum at New York and the Brooklyn Museum at Brooklyn contain valuable material. Besides these, the collections at the Alabama Polytechnic Institute and the Rhode Island Agricultural College are worthy of mention.

* NOTE.—Since finishing this paper the writer has seen an article on this group by Mr. N. Banks (New Scolioidea, Can. Ent., XLIV, p. 197, 1912). Although arriving too late for consideration in this paper, it does not appear probable that it would involve any changes in it.

HISTORY

The genus Scolia was established by Fabricius in 1775. In 1802 Latreille established the family Scoliites, including the genera Sapyga and Scolia. In 1810 Latreille designated *Scolia quadripunctata* as the type of the genus Scolia. In 1817 Leach established a tribe Scolides containing two families, the Tiphida and Scolida. In the latter family he made two divisions to which he gave no names, placing in the first division the genera Myzine and Meria and in the second division the genus Scolia, while he placed Sapyga in a separate tribe, the Sapygides. Westwood in 1839 changed Leach's tribe Scolides to the family Scoliidæ including under this the subfamily Scoliides and mentioning the genus Tiphia but not Scolia, apparently because Scolia did not occur in Great Britain. For his second subfamily he adopted Leach's tribe Sapygides thus bringing together under the family Scoliidæ Leach's tribe III Scolides, and tribe IV Sapygides. He does not appear to have recognized Leach's families Tiphida and Scolida.

Cresson, 1887, included under the family Scoliidæ, Tiphia, Paratiphia, Myzine and Scolia, placing the Sapygidæ as a separate family.

Ashmead, 1903, removed everything from the Scoliidæ except Scolia and Elis and a few genera so closely related to these that they have frequently been regarded as only subgenera. He also made two subfamiles the Scoliinæ and Elidinæ (now Campsomerinæ). Here Ashmead designated the type of Scolia as *Scolia flavifrons* Fab. evidently following Bingham who (Fauna Brit. India: Hymen., Vol. I, p 89) had already designated that species as the type of the genus.

May 26, 1911, S. A. Rohwer, in No. 1837 of the Proceedings of the U. S. Nat. Museum Vol. XL, pages 551–587 calls attention to Latreille's paper in 1810 and writes as follows:

"Family Scoliidæ, genus Scolia Fab. Type *Scolia quadripunctata* Fab. Latreille 1810. Mr. C. Schrottky has contended that the type of the genus Scolia Fab. is *Scolia atrata* Fab. *Scolia atrata* was the first species included and according to the system used by Saussure and Sichel, belongs to Elis. In stating that the type of Scolia is *atrata* Fab., Schrottky adheres to the antiquated first species rule. This adherence is unfortunate as the idea has been entirely done away with by most

systematists in all groups of animals, as well as being ruled against by the International Congress of Zoological Nomenclature."

The genus Scolia as originally defined by Fabricius included 10 species. The eighth species, *Scolia quadripunctata* Fab., was chosen as the type by Latreille in 1810. No older designation of type for this genus is known to the writer, therefore *Scolia quadripunctata* Fab. is considered the type of the genus Scolia. From this it is evident that the designation of Scolia *flavifrons* as type of the genus cannot hold.

Saussure and Sichel divided genus Scolia into the subgenera Triscolia and Discolia. As already stated *Scolia flavifrons* was selected by Bingham as the type and belonged to the subgenus Triscolia. The type *Scolia quadripunctata* selected by Latreille belongs to the subgenus Discolia however and upon raising these subgenera to generic rank, Discolia becomes a synonym of Scolia while Triscolia, regarded by Ashmead as a synonym of Scolia because *flavifrons* which he selected for the type belonged in that section, necessarily is restored from a synonym to a valid genus. Triscolia was established by Saussure and Sichel and under it were placed twenty-five species, none of which was designated as the type. So far as the writer has observed the only species of this list which has been designated as the type since, is *Scolia flavifrons* Fab. which was done by Bingham as already indicated. Accordingly therefore the subfamily Scoliinæ may be considered so far as North America forms are concerned, as including the genus Scolia with *Scolia quadripunctata* Fab. as its type, and the genus Triscolia. As the latter had the species *flavifrons* designated as its type when it was supposed that it was a synonym of Scolia, it would seem desirable to retain this same species as the type now that it has become an established genus. *Scolia flavifrons* Fab. is therefore here designated as the type of the genus Triscolia, no earlier designation for this genus having been observed.

The above is the history of this group that the writer wishes to adhere to, yet Schrottky in the Deutsch Ent. Zeitschr 1910, Heft II, page 196 says that Triscolia of Saussure and Sichel should become Ascoli of Guerin. In tracing Ascoli back to the reference, (Guerin, Duperry: Voy. Coquille. Zool. II, 1830, page 247,) I find it indeed true that this is the first reference to the insects included in the group Triscolia, that is so far as can

be ascertained by a study of the work concerned, for the factors which were used to separate the sections of Guerin's groups when compared with the important writers on Scolia become hard to discern. The following is a translation of Guerin's classification leading to Ascoli:

I. Superior wings with four cubital cells.
(The writer's three *closed* cubital cells.)
II. All the cubital cells reach to the radial cell.
A. Two recurrent nervures. (Cosila).
B. One recurrent nervure. S. G. Ascoli.

As an explaining phrase Guerin writes beneath division B "Nous n'en connaissons pas encore." Of course he does not give any examples as he has under his other divisions in his tables. Under these conditions the writer is not yet prepared to use the term Ascoli. If it should ever be adopted the writer sees no reason why *Scolia flavifrons* Fab. could not still remain the type under this older name.

HABITS.

Having never been able to study this group of insects in the field the writer has been obliged to depend on other writings on Scolia for information as to their habits. Westwood says that the genus Scolia comprises many species, inhabiting the hottest regions of the globe. Dufour states that Scolia hortorum abounds in the very hottest situations and that it is very fond of revelling in strong scented flowers. A correspondent of the Entomological Magazine (Vol. III, p. 436) states that Scolia bicincta Fab. makes its burrows in sand banks, to the depth of eighteen inches, with a very wide mouth; in digging into one a female had entered he found a large locust, L. lineola, which is probably its prey. The males of this genus are usually taken singly on flowers, but the males of Scolia interrupta and four-punctata, which are extremely sluggish, are found crowding on the ears of grass near the seaside, where they pass the night. Latreille thought that Scolia punctata was parasitic upon some of the bees which build in old wood, and Shuckard states he caught S. punctata entering into the cells of Osmia bicormis. Robineau Desvoidy has proved this fact, having found cocoons of S. punctata in the cells of Osmia helicicola, in which situation he observed the metamorphosis of this species without however, having detected the female in her operations. Riley in the sixth report of the Missouri

State Entomologist says that *Scolia flavifrons* attaches its egg to the venter of the larva of a common European lamelicorn beetle larva. Ashmead, Can. Ent. 35, states: "So far as is known the species are parasitic upon the larvæ of ground beetles belonging to the family Scarabæidæ and probably also upon other ground inhabiting beetle larvæ."

The following is a translation from Burmeister (Naturf. Ges. Halle): To see strange insects emerge from ant heaps is always surprising to the entomologist; he has every reason to assume that, if this is repeated often, then a normal condition exists. This is true of *Scolia campestris* of Brazil. I am therefore inclined to the opinion the *Scolia campestris* lives in the inside of the ant hills as larvæ and probably feeds as a parasite on the larvæ of the *Atta cephalotes*.

Such observations as the above would seem to imply that the insects belonging to the family Scoliidæ are parasitic on larvæ of a great many insects and that they are solitary, never living together in numbers in the same nest. The males are very apt to frequent highly scented flowers and a great many that the writer has examined show this, because the body, usually quite hairy, is well covered with pollen grains in many cases. So little data has been submitted on the habits and life of this group that an investigation of them should prove worth while and very interesting.

EXTERNAL ANATOMY.

HEAD. Viewed from in front the hypognathous head is subcircular but apparently elongated beneath by the projecting mandibles. At the sides are the somewhat kidney shaped eyes, made so by a deep emargination just above the middle of the inner borders which leaves the lower lobe much larger. In the male the emargination is well up toward the top of the head causing the lower lobe to be comparatively much larger than in the female.

Clypeus. The clypeus extends downward from the bases of the antennæ, its edge between these points being emarginated. Laterally it extends nearly to the eyes, the suture curving downward somewhat, and is separated from the eye by a narrow extension downward of the frons. Its lower margin varies from a broad gentle curve to nearly a straight line in some cases and this margin is liable to be reflexed. In the male the clypeus

is more triangular in outline, with the base of the triangle below. Except for a small area in the center it is punctured everywhere, the punctures gradually becoming deeper and closer from the central space outward. It is more or less covered with short stiff hairs but the whole surface has a shining appearance.

Frons. The frons extends upward from the base of the clypeus to the ocelli where it joins the vertex though no suture is present.

There is a downward projection on each side of the clypeus to the base of the mandible, narrow in the male and wide in the female. A transverse suture extends just behind the ocelli and then in some cases a little forward and outward toward the eyes. The antennæ are inserted in the frons close to its lower border, beneath two strongly developed oblique ridges, these insertions being slightly farther apart than the distance of either from the compound eye. The frons is more or less deeply punctured and hairy, particularly so between and around the base of the antennæ. The hair may become worn away to very short stubs, apparently a result of the digging habits of the insect.

Ocelli. The anterior ocellus is the larger. Behind the ocelli the head gradually rises to its highest point. It is rather sparsely punctured near the ocelli but behind its highest point its punctures become quite close again. This portion of the head may be termed the vertex but no sutures are present separating it either from the cheeks at the sides, the frons in front of the ocelli, or the occiput behind. The hinder part of the head behind the vertex and cheeks bears a narrow semi-circular ridge within which is the articulation with the thorax. The back of the head close to the ridge is thickly clothed with rather long, stiff hairs.

Cheek. The portion of the head behind the compound eye is called the cheek. Viewed from the side it is widest behind the top of the eye. For a short distance downward it is of about the same width and then narrows very rapidly to the base of the mandibles. It is punctured and hairy more or less everywhere.

Labrum. A short distance above the lower edge on the inside of the clypeus the labrum is attached. In preserved specimens it is bent backward at right angles to the clypeus,

covering the cavity which holds the folded sucking mouth parts. With the large mandibles closed over it the labrum is not accessible for study except by dissection. There has therefore been no attempt made to use its characters for classification.

Mandibles. Each mandible is a fairly long and strong hook decidedly suggesting rapacious habits. The front surface has a deep longitudinal furrow at its inner border while the hind surface is set with stiff outstanding bristles, extending from a deep furrow at its outer border. Between these two and on the front surface is a third shallow furrow which runs the whole length of the mandible. A study of many individuals shows a variation in the structure and relative proportions of the mandibles, they probably being worn and modified by the digging habits of this group. In the female the middle of the inner margin sometimes shows tiny blunt projections (hardly long enough to be called teeth) varying in size with the different species and in the same individual. The male mandible is more delicate than the female. Its inner middle margin shows three well defined teeth besides the sharp end tooth. The surface of the mandibles is smooth and shining.

The maxillary palpus is composed of six segments and the labial palpus has three segments.

The other mouth parts cannot be studied except after dissection and therefore are not readily available for analytical work. For this reason they are not considered here.

Antennæ. In the male these are long, almost cylindrical and almost straight. The basal portion of the first segment or scape is a small spherical bulb which has every appearance of being a separate segment. This is not the general opinion however so it is here considered a part of the scape. The distal portion of the segment is long and very near a perfect cylinder. It narrows quickly at either end to articulate with the bulb and the pedicle. The pedicle is small and cup-shaped, its smaller end toward the body. These segments are smooth and shining. The filament consists of eleven cylindrical segments, very little thickened in the middle and only separated from each other by a fine seam. As a whole it is stout gradually increasing in diameter to near its end, then gradually reducing. The segments of the filament are considerably longer than their diameter and are dull, not reflecting the light.

In the female the antennæ are more condensed, being thicker and shorter. The scape is large, stout, elongate-ovate, with its greatest diameter near its outer end. The second segment is similar to that of the male but articulates somewhat obliquely with the scape which tends to turn the outer part of the antenna backward. The ten segments of the filament with the exception of the last are no longer than their diameter and articulate with each other quite obliquely. Their surface in general is dull though the first segment or two may be somewhat glistening. The outline of the filament as a whole resembles that of the male.

THORAX. The pronotum aside from the portion forming the upper side of the neck extends to the tegulæ, below which it projects a little farther backward. From this point its edge then runs forward and downward, forming a curve to the base of the fore coxæ. Between the tegulæ its margin is deeply excavated to accomodate the front of the mesonotum. The front margin of the prosternum on the neck is considerably posterior to that of the pronotum making the articulation with the head quite oblique. A Y-shaped groove a short distance behind its anterior margin separates what may be considered the neck portion of this plate from a swollen lateral lobe on each side, at the hind end of which the fore coxa articulates.

The surface of the pronotum is more or less coarsely punctured and provided with hairs except along a strip where its neck and vertical portions meet. The sternum is everywhere similarly punctured but the hairs along the Y-shaped groove are much smaller and decumbent.

The mesonotum is a broad convex plate, very near a regular hexagon in outline, lying between the wings and extends forward to the prothorax, and to the tegulæ at the sides. From the middle of the anterior edge a groove extends backward varying in length and distinctness. From a point just inside of the place where the edge of the scutellum joins the mesonotum a pair of grooves pass forward from its posterior margin parallel to each other. These grooves varying in length, depth and width are probably the parapsidal grooves. The mesonotum is coarsely but somewhat sparsely punctured except near its center which is smooth. Just behind the mesonotum lies the scutellum. It is more or less deeply punctured and hairy, and is a transverse plate with its central portion

raised about as high as the mesonotum. Its sides are abruptly bent downward along a line beginning at the parasidal grooves and extending backward and toward the center of the body giving this portion the form of a trapezoid whose basal angles are equal, with its longest base toward the anterior end of the body. The lateral, sharply depressed portion of the scutellum narrows quickly as it passes outward and downward and the hind wing arises from just behind its outer end while the fore wing arises somewhat lateral to its outer end which extends forward somewhat below the hinder corners of the notum.

The mesothoracic pluron is large and lies below the wings. The whole surface of this plate is gradually raised to a rounded ridge which runs downward and backward through its middle and is more or less hairy and coarsely punctured. The anterior margin of this plate is indicated by a curved suture running downward and slightly forward to the base of the fore coxa while its posterior margin is indicated by a suture starting just in front of the margin of the posterior wing and running downward and backward to the highest point of the mesocoxa in front of which it forms the anterior edge of the coxal cavity. This plate fuses beneath with the mesosternum, no suture being present to separate the plates. The anterior margin of the mesosternum is formed by the contiguous fore coxæ and its posterior margin is in part formed by the inner sides of the mesocoxal cavities and in part by a free edge between them, the two mesocoxal cavities being suddenly separated. The intercoxal margin of the mesosternum varies from a nearly straight to a more or less curved line with a notch in the middle. A longitudinal median line varying in distinctness divides the mesosternum into two equal parts. The mesosternum is more or less coarsely punctured and haired.

The postscutellum which lies just behind the scutellum is a similar plate but a little narrower. Its central portion is raised to about the same height as the central portion of the scutellum and becomes narrow behind and then broadens somewhat, close to its hinder margin. Its sides beginning on a line with the sides of the scutellum are abruptly bent downward to correspond with the similar portions of the latter plate and its margins running downward and forward nearly parallel, end at the base of the posterior wing. The plate is more or less coarsely punctured and haired.

The metapleuron extends downward and backward from the base of the posterior wings. Half-way between the base of the wings and the base of the metacoxa the plate narrows and appears to be separated into two parts by a transverse furrow. The upper part is very near the shape of a triangle, with one side, the hinder one, rounded. The lower part continues downward and backward between the edges of the median segment behind and the mesopleuron in front forming the posterior part of the mesocoxal cavity, the upper and anterior parts of the metacoxal cavity and passing between the two coxal cavities to unite with the metasternum though there is no trace of the suture between these two plates. Both parts of the metapleuron are more or less coarsely punctured and hairy. The metasternum extends backward from the mesosternum between the meso and meta coxæ, its sides in part forming the ventral edges of the coxal cavities and the apparent posterior margin is free. This part of the metasternum is only sparsely punctured and covered with hairs while its shape varies. It has a median groove extending forward from the apparent hinder margin for a varying distance. This apparent hinder margin is not the real one, however, the plate turning backward on itself for a short distance, then bending at right angles and passing dorsalward, thus forming a backward projecting flange. The vertical portion is bilobed and at its dorsal magrin (the real posterior margin of the plate) articulates with the sternal plate of the petiolar segment. This flange is covered with coarse punctures and long coarse hair.

MEDIAN SEGMENT. The median segment is really the first segment of the abdomen which has become closely connected with the thorax and has often been considered one of the segments of this division. It is followed by the petiole, a constricted portion which extends backward and suddenly enlarges to the regular size of the abdominal segments. For any morphological consideration this arrangement should be remembered but for convenience in this paper the petiole with its enlarged portion is considered the first segment of the abdomen.

Viewed from above the median segment appears to be composed of a central portion and a lateral portion on each side, the separation of these parts being indicated by a depressed line or shallow groove arising at the front margin of the plate nearly opposite the point where the central elevated part of the

postscutellum joins the side portion and becomes depressed. These two lines converge as they pass backward and continue to the sides of the base of the petiole. The central portion of the median segment extends backward a distance about equal to the length of the scutellum then sharply bends downward to the petiole, its two surfaces forming nearly a right angle. Both of these surfaces bear coarse punctures and hairs. A short distance behind the upper posterior corner of the metapleuron a long narrow, nearly vertical, spiracle occurs near the anterior margin of the latter portion of the median segment. The groove separating the metæpisternum from the metæpinuron appears to continue upward and backward into the side of the median segment, passing below the spiracle and extending a short distance behind it. From a point near the lower end of the spiracle this lateral portion appears to become sharply compressed into a dorsal, nearly horizontal and a lateral surface, the latter being so bent inward that the sides of the insect in this region actually overhang. These lateral portions extend somewhat farther back than does the central portion so that the posterior end of the median segment as a whole has its lateral corners projecting farther backward. At its lower hinder edge the median segment articulates above with the dorsum of the petiolar segment. The surface of the lateral portions is more or less coarsely punctured and haired.

ABDOMEN. The abdomen has six visible segments in the female and seven in the male which excepting the first and the sixth, seem to have no structures of importance. The part of the abdomen behind the petiolar segment viewed either from above or below enlarges for a short distance then gradually narrows in a regular curve, to where a pair of spines project from the surface of the last segment. The sternum of the second segment shows a distinct anterior face where it bends abruptly downward from its articulation with the posterior lower margin of the petiolar sternum, thus giving the middle portion of the abdomen its greatest vertical diameter. Behind the second segment the distance apart of the dorsal and ventral plates gradually decreases. The surface of each segment is more or less coarsely punctured and hairy and close to the posterior margin of each the punctures are more numerous. From these punctures project stiff hairs overlapping the anterior edge of the next segment beyond, to form a fringe. All the hairs are quite decumbent particularly those above.

In proportion to the rest of the insect the abdomen as a whole is heavy causing it to sag downward and gives the insect a clumsy appearance especially the female.

First segment of the abdomen. The narrow part of the first segment of the abdomen known as the petiole, viewed from above is about one-third as wide as the median segment or of the widest portion of this segment itself while the vertical diameter of this part is about two-thirds its width. It continues backward from the base of the median segment for a very short distance then rises sharply and gradually broadening, to a point about the level of the top of the median segment. It then bends backward to form the dorsal surface of the hinder non-petiolar portion of this segment. The ventral part of this segment is divided into two portions. The first is a small, convex, somewhat oblong area with rounded corners and a posterior median shallow notch, the whole much resembling in form the labrum of some Acrididæ. Its surface is finely and closely punctured and is well covered with long hair.

The posterior portion of this sclerite is markedly triangular, all its margins being concaved. The posterior angles are quite sharp but the anterior one where it joins the front section first described is about the width of the petiole. The posterior margin has a rather dense fringe of short backward directed hairs. The surface of this portion of the sclerite is rather sparsely covered with punctures and hairs.

A somewhat triangular projection forward and outward from the anterior corner of the second dorsal abdominal plate seems to wedge itself between the hinder corners of the notum and sternum of the first segment and a line arising near the base of the projection on the notum of the first segment and running obliquely downward and forward to meet the lateral margin of this plate at the hinder edge of the first section of the sternum already described may perhaps represent the former line of separation between the notum and pleuron in this segment: if so the pleuron is now the lateral margin and an actual part of the notum.

Last segment of the male. The terminal segment of the male requires a separate description. In this sex the lateral margins of the dorsal sclerite overlap the corresponding margins of the sternal sclerite from the base of the segment backward to the point where a lateral spine protrudes from between the two

plates of the segment. From this point backward there is no lateral portion to the plate it being entirely dorsal and with its margin rather oval in outline varying somewhat perhaps in some species.

The base of the ventral segment at its sides is concealed by the lateral margins of the dorsal plate. Its lateral margins are nearly parallel almost to the end of the segment, the hinder margin being very broadly and bluntly acuminate. Along the median line of the plate extends a distinct ridge.

Between these two plates projects the end of a third, only the outer portion of which is strongly chitinized. Its sides are approximately parallel and at the hinder end it bears three spines one in the center and one at each corner. The median spine is larger and stouter than the lateral ones and extends backward some little distance into the body of the plate forming a distinct central ridge on the under surface. The body of the plate as a whole is somewhat convex from side to side beneath. The homology of this three spined plate has not been worked out by the writer but as the reproductive organs are just above it, it would seem not impossible that it is the ventral plate of another segment partly drawn within the one described as terminal and of which the dorsal portion has either been lost or at least has not been observed in the course of this work.

Last segment of the female. The lateral margins of the last dorsal sclerite in the female are considerably prolonged ventrally over the corresponding margin of the sternum of this segment thus concealing the latter. The edge of this portion extends backward and upward to the base of the spine near the margin on the ventral plate (to be described later) above which it turns backward and gradually inward to form the hinder margin. The outline of this portion varies greatly in different species. On the side of the dorsal plate near its base and close to the edge of its dorsal surface a ridge arises extending backward and finally ending above the more or less spine-like structure of the ventral plate. This ridge varies in form in different species.

The last ventral plate in the female is quite convex from side to side and its lateral margins turn inward almost horizontally, the two edges nearly meeting at the nearest point. This inflexed portion of each side is concealed by the dorsal plate only the hinder margin which varies in outline in different

species, being visible. At the side of the visible portion of the plate close to the margin of the dorsal sclerite is a projection more or less of the form of a spine but sometimes shorter and with a blunt end. It projects outward and backward from the general surface of the body at this point and its antero-posterior location on the plate varies somewhat in different species.

WINGS. The wings of this group as far as observed are generally fuliginous with a bluish, purplish, or even somewhat greenish reflection. In a few cases the wings are nearly hyaline but then are liable to have a yellow tinge and more or less well developed fuliginous areas particularly toward the apex, and at these places the reflection appears.

In this paper wing areas entirely enclosed by veins are termed closed cells while those not entirely enclosed by veins and extending to the margin are regarded as incomplete or open cells. At the base of the wing are three rather long closed narrow cells. These passing backward from the costal margin are respectively, the costal, median and submedian cells. Between the latter and the hinder margins is an open anal cell. Between the outer end of the costal cell and apex of the wing are two closed cells, the one next to the costal occupying the place where the stigma is usually found and which may therefore be called the stigmal-cell. It is quite narrow. External to this is the much larger radial cell and extending from the latter to the apex, is a large open cell. Behind the stigmal cell lies the first cubital, lying behind the outer end of the costal cell and at the outer anterior corner of the median cell while its outer end is behind the inner portion of the radial cell. Behind the greater part of the first cubital and the radial cells lies the second cubital and in some cases, is a small closed cell, the third cubital between the outer end of the second cubital and the apex of the wing. The area sometimes occupied by the third cubital cell is sometimes thrown into the open cell already referred to which extends to the apex of the wing, there being no third cubital present in such cases. Behind the outer part of the median, the base of the first cubital and the base of the second cubital cells, lies the first discoidal and at the outer end of the submedian and behind the basal half of the first discoidal lies the second discoidal cell. External to the second discoidal cell and behind the outer parts of the first discoidal and second cubital cells lies the third discoidal cell, combined

with the second apical cell which is open at its outer end, no cross vein separating these two being present in the American members of this subfamily. Behind this cell is a space extending to the hinder margin, the first apical cell.

There is a variation in the number of cubital and discoidal cells and upon this variation depends the separation of the group into genera. There also seems to be a variation in the shape of the radial and cubital cells which may be of some specific value. The radial cell differs in the different sexes and there seems to be an area more or less confined to the costal, median, stigmal, first cubital and radial cells which is usually covered with hairs. The region beyond the closed cells is very finely striate with parallel lines. This fact alone would serve to separate this subfamily from two of its nearest allies, the Myzinidæ and Tiphiidæ if other structures were not available.

The veins which appear in the front wing of this group are the costal, subcostal, externo-medial, anal, basal, first, second and third transverse cubital, transverse medial, discoidal, cubital, first recurrent and subdiscoidal veins. Their arrangement and relation to each other are shown by figure. Either the presence or absence of a third transverse cubital nervure causing either the presence or absence of a third closed cubital cell is a generic character as before stated.

The fact that there is but one recurrent nervure is of subfamily value separating the Scoliinæ from the Campsomerinæ, the other subfamily of this family Scoliidæ.

Along the central portion of the hinder margin of the anterior wings just internal to a nearly central notch of this margin on the anal cell is a fold known as the frenal fold, in which the frenal hooks of the hind wing catch so that the two wings may act together.

There seems to be nothing of systematic importance in the structure of the hind wing. About one-third of the distance from the base of the wing on the posterior border there is a deep narrow sinus and at about the center of the anterior border are the frenal hooks spoken of above. Except for a very few hairs mostly near the costal border the hind wing is naked.

TEGULA. The tegula is a small three sided, very convex, plate lying over the base of the fore wing, separating it from the dorsal plate of the prothorax in front and from the mesonotum above. The surface of the tegula is usually smooth and shining

except near its base where it shows a few punctures and hairs. Beneath the base of each wing there is only one principal long narrow plate, called the subalar by Crampton in a treatise on the thorax of insects in 1909. Above the base of each, just behind the tegulæ are located two plates which probably represent detached portions of the basal parts of the veins of the wings.

LEGS. The legs of this subfamily are not long but are stoutly built, the general structure being reenforced by spines and hairs of unusual length and thickness especially in the female. The front legs of the female are especially developed probably to aid in digging in the earth.

The coxa, trochanter and femur of the front leg have no spines in either sex. The femur of the middle leg in the female however bears on the outer side of its outer end, one or sometimes two small spines and at the same place on the hind femur a transverse row of similar spines. In the male the mid femur has, in rare cases, such a spine at the above location and the posterior femur always bears a row of short spines at the same place. The other segments of the legs are more or less covered with rows or else isolated stout spines especially in the female. The front legs in both sexes are always the shortest and the parts beyond the femur in the female are somewhat flattened. The size and length of the legs increases from in front backward and the length of the first tarsal segment in the three pairs of tarsi from front to rear is very nearly in a ratio of one, two and four in both sexes.

In the front leg the tibia is much shorter than the femur; in the middle leg it is but little shorter; while in the hind leg the two segments are about equal in length.

The mid coxæ are always far apart, (a character used to separate the Scoliidæ from the other closely allied families) and are small globular or subconical in form. The fore and hind coxæ are quite large, of about the same size and conical. The former are contiguous but the latter are widely separated.

At the top of the last tarsal segment is a pair of simple claws, (a character used to separate Scoliidæ from the Myzinidæ). Between these claws is a good sized pulvillus.

At the end of the tibia there are always several spines and at the end of the middle tibia is always a spine much larger and longer than the others, while at the end of the hind tibia there

are always two such spines of about equal length and much larger and longer than the others.

All the segments of the legs are more or less covered with coarse punctures and long hairs.

The three pairs of trochanters are well developed and are longer at the outer end where they articulate with the femur which also enlarges outward to where it articulates with the tibia. The fore tibia has at its end just beneath its anterior edge a large, curved, much modified spine which in connection with a corresponding modification at the base of the first tarsal segment, acts as a cleaning apparatus. Beginning at the base of this enlarged spine on the tibia and extending backward along the anterior margin is an area of short, fine hairs set close together to form a pad-like structure. This is not so strongly developed in the male but there is a sericeous appearance in its place. Beneath the hind margin near the outer end three stout spines usually project and a row of short stout spines projects from beneath the edge of the end.

There are five tarsal segments. The first and fifth are much longer than the others and in the female the tarsal segments of the fore leg are somewhat flattened. Their posterior edges bear a row of long stout spines and their ends and anterior edges have a row of similar spines except the part of this edge of the first segment which is opposed to the large modified spine of the tibiæ. Here the edge is sharply concave and has short, blunt, tooth-like projections. On the ventral surface of the same segment, behind this concave edge and near its base, a row of long stiff hairs projects downward.

The dorsal surfaces of the mid and hind tibiæ are set with longitudinal rows of stout spines. The mid and hind tarsal segments except the last, are cylindrical and bear irregularly set spines. Their ends are encircled by a row of stout spines.

The relative size of the segments of the legs increases from front to rear and there are no spines on their ventral surfaces.

SEX DIFFERENCES. Most of the differences of sex have been mentioned above. Some of the more conspicuous are restated as follows: In comparison with the female, the male is much more slender and always smaller. The outline of the clypeus is much different; the antennæ of the female have twelve segments which are short, blunt and recurved while those of the male have thirteen segments and are long, slender and usually

straight. The female abdomen has at its end a sting while the male has three sharp spines. The segments of the fore tarsi in the female are flattened somewhat while those of the male are cylindrical. Legs of the male have fewer spines and hairs than those of the female which present a very bushy appearance. The abdomen of the female has six segments and that of the male seven.

GEOGRAPHICAL DISTRIBUTION.

The insects of this group occur in all the continents of the world but are most abundant in tropical regions. There the specimens are usually very large and although in the greater number of cases the ground color is very dark or black, there are spots, bands, etc., of the brighter colors.

Specimens of this group become more and more rare as the climate becomes colder. Apparently the Upper Austral zone marks their northern limit with perhaps the exception of occasional stragglers into the Transition zone.

Within the territory this paper attempts to cover, namely North America, the species of the subfamily Campsomerinæ seem to far outnumber those of the Scoliinæ.

Subfamily SCOLIINÆ Ashmead.

SCOLIA: Fab., Syst. Entom. 1775, p. 355, n. 111.
SCOLIETÆ: Latr., Hist. Nat. Ins., 1805, Vol. XIII, p. 270.
SCOLIDA: Leach, Edinb. Encyl., 1812.
SCOLIDES: Leach, Encyl. Brit., 1817.
SCOLIDA: Leach, Edinb. Encyl., 1817.
SCOLIITES: Newm., Ent. Mag. II, 1834.
SCOLIIDÆ: Westw., Intr. Class. Ins., 1840, Vol. I, p. 82.
SCOLIIDES: Westw., Intr. Class. Ins., 1840, Vol. I, p. 82.
SCOLIA: Burm., Abh. Naturf. Ges. Halle, 1853.
SCOLIA: Sauss. and Sichel, Cat. Spec. Gen. Scolia, 1864, p. 14, genera Scolia and Elis.
SCOLIA: Cresson, Syn. of Hymen. of Amer. north of Mex., 1887, p. 108.
SCOLIA: Bingham, Fauna Brit. India; Hym., Vol. I, 1897.
SCOLIIDÆ: Ashmead, Can. Ent., Vol. XXXV, 1903, p. 7.
SCOLIINÆ: Ashmead, Can. Ent., Vol. XXXV, 1903, p. 7, (subfamilies Scoliinæ and Elidinæ).
LIACOSINÆ: Schrottky, Deutsch. Ent. Zeitschr., 1910, Heft. II, p. 196.
SCOLIIDÆ: Rohwer, Proc. U. S. Nat. Mus. Vol. XL, p. 552,1911.

SYNOPTIC TABLES FROM VESPOIDEA TO SUBFAMILY SCOLIINÆ

The writer has used portions of Ashmead's tables published in the Proceedings of the U. S. National Museum, Vol. XXIII, and in The Canadian Entomologist, Vol. XXXV.

Abdomen sessile or petiolate, with the first ventral segment distinctly separated from the second by a more or less deep constriction or transverse furrow; legs most frequently fossorial.....1.

1. Middle coxæ contiguous or nearly so.
Cosilidæ, Rhopalosomidæ, Thynnidæ, Myrmosidæ, Mutillidæ.
Middle coxæ distant, usually wide apart.....2.

2. Stigma of front wing not well developed, at most only slightly developed, either very small or linear; eyes most frequently emarginate within; middle tibiæ with two apical spurs.....3.
Stigma of front wing well developed, ovate or subovate; eyes entire, never emarginate within; pygidium in male entire, the hypopygium terminating in a sharp aculeus, which curves upward.....*Tiphiidæ.*

3. Pygidium in male entire or at most with only a slight sinus; the hypopygium ending in three spines; claws simple.....*Scoliidæ* 4.
Pygidium in male deeply emarginate at apex, the hypopygium terminating in a sharp thorn or aculeus, which curves upward and rests in the emargination of the pygidium; claws cleft.....*Myzinidæ.*

4. Front wings with only one recurrent nervure; if with two the second recurrent is incompletely formed, and bends backward so as to unite with the first; the second cubital cell receiving only one recurrent nervure .....Subfamily *Scoliinæ.*
Front wings with two complete recurrent nervures, both of which are received by the second cubital cell.....Subfamily *Elidinæ.*

TABLE OF SPECIES.—SCOLIINÆ.

1. Fore wing with three closed cubital cells .....**Triscolia.** 2.
Fore wing with two closed cubital cells.....**Scolia.** 3.

2. Black; abdominal segments beyond the second, reddish brown; wings with slight greenish reflection.....**T. fervida** Burm. (315)
Entirely reddish brown; wings with a strong green metallic reflection...
T. badia Sauss. (314)

3. Body entirely without color markings.....4.
Body not entirely without color markings.....6.

4. Second abdominal segment more or less tubercular beneath.....5.
Second abdominal segment not more or less tubercular beneath.....
S. monticola Cam. (330)

5. Body entirely black, hairy and densely punctured. Wings dark fuliginous. A darker area along the costal border.....**S. guttata azteca** Sauss.. (326)
Body entirely dark brown, smooth and shining; wings light fuliginous throughout.....**S. cubensis** n. sp. (318)

6. Body with yellow markings.....7.
Body without yellow markings, head and thorax black, segments of the abdomen beyond the second, ferruginous..**S. dubia hæmatodes** Burm. (320)

7. Second abdominal segment more or less tuberculate beneath.....8.
Second abdominal segment not more or less tuberculate beneath.....9.

8. Wings with metallic color reflections, blue and purple, larger hind tibial spur less than one-half the length of the first tarsal joint.....
S. guttata guttata n. subsp. (325)
Wings without metallic reflections, shiny brown, length of the longest hind tibial spur about one-half the length of the first tarsal joint....
S. fuscipennis n. sp. (324)

9. Venter of the abdomen all black.....10.
Venter of the abdomen ferruginous or partly so.....11.

10. Head all black, body covered with black hair. Free edge of the clypeus a regular curve.....**S. bicincta** Fabr. (316)
Head with yellow marks behind the eyes, body covered with grey hair. Free edge of the clypeus very near a straight line with the lateral edges meeting this edge close to the perpendicular. **S. vintschgaui** D. T. (336)

11. Thorax all black, dorsum of third abdominal segment has two oval yellow spots.....**S. dubia dubia** Say. (319)
Thorax not all black.....12.

12. Venter of abdomen all ferruginous, body covered with greyish white hairs, antenna slightly ferruginous.....**S. fulviventris** n. sp. (323)
Venter of abdomen not all ferruginous, maybe black or yellow ferruginous. 13.

13. Thorax covered with yellowish grey hair; antenna black. **S. consors** Sauss. (317)
Thorax not covered with yellowish grey hair. (Yellow or darker).....14.

14. Wings fuliginous throughout.....**S. nobilitata** Fabr. (332)
Wings not fuliginous throughout.....15.

15. Ventral abdominal segments beyond the second, dark ferruginous slightly mottled with yellow; dorsal segments 3, 4, 5, 6, yellow except the anterior edges slightly ferruginous.....**S. otomita** Sauss. (333)
Ventral abdominal segments beyond the second, not dark ferruginous and not mottled with yellow.....16.

16. Head all black except yellow marks behind the eyes and along the inside edges of the lower lobes of the eyes.....17.
Head, except yellow marks behind the eyes and along the inside edges of the lower lobes, not all black.....18.

17. The dorsum of the abdomen has no yellow on it, except on the third segment which has two oval yellow spots.....**S. inconstans** Cress. (327)
The dorsum of the abdomen beyond the first segment, more or less marked with yellow.....**S. flavocostalis** Cress. (321)

18. Top of head behind the lower ocellus and body color of the thorax black.....**S. lecontei** Cress. (329)
Top of head behind the lower ocellus and body color of the thorax ferruginous.....**S. ridingsii** Cress. (334)

DESCRIPTIONS.

The lists of references to these insects given by Saussure and Sichel and especially by Dalla Torre are so full that it has not seemed necessary to copy them here. It has therefore been my intention only to make the American references complete by publishing any that were not in Dalla Torre's Catalogue:

Genus **Triscolia.** Saussure and Sichel.

Genus *Triscolia.* SAUSSURE and SICHEL, Cat. Spec. Gen. Scolia, 1864, p. 14.

Generic characters: Three closed cubital cells.

Type: *Scolia flavifrons* Fab.

BIBLIOGRAPHY.

Ascoli GUERIN, Duperry, Voy. Coquille, Zool. II, 2, 1830, p. 247.
Triscolia SAUSS. and SICHEL, Cat. Spec. Gen. Scolia, 1864, p. 14. (subgenus).
Scolia BINGHAM, Fauna. Brit. India, Hymen., Vol. I, 1897.
Scolia ASHMEAD, Synopsis, Can. Ent., 1903, p. 7, (subgenus).
Ascoli SCHROTTKY, Deutsch, Ent. Zeitschr., 1910, Heft. II, p. 196.

Triscolia badia (Saussure).

Scolia badia SAUSS. Am. Soc. Entom. France (4), III, 1863, p. 17 ♀ ♂.

The location of the type is unknown to the writer.

Saussure and Sichel have recorded the female of this species as 31 mm. in length and the male as 18 mm. in length. The specimens that the writer has personally examined vary, the females ranging from 22 to 26 inches in length. Only one male was examined. It measured 19 mm. in length.

The body of the species is reddish brown except for a few parts which are black or have black markings. The wings are uniformly fuliginous with metallic reflections, green at some angles, blue at others and purplish at others. The nervures are dull black. This species is one of the largest found in the group.

The specimens which the writer has examined agree well with Saussure's description of the species and also with a good illustration published in Saussure and Sichel's Catalogue, plate IX, except for a few details. In the female the antenna, except more or less of the scape, is black as is also the end and more or less of the margin of the mandible. The small inner plate at the base of the fore wings behind the tegula is also black. In addition a number of the thoracic sclerites frequently show a slight tendency toward blackish at their margins and this also is the case with the lateral and hinder margins of the last ventral abdominal plate. The tips of the claws are also nearly black. The coarse hairs clothing the body are orange yellow, lighter than the color of the plate from which they arise.

In the male the antennæ are entirely black except the underside of the scape which is dull ferruginous. The head from the insertion of the antennæ upward is black except for the emargination of the eyes and a narrow light band behind the eyes which widens below. The tips and inner and outer margins of the mandibles are dark reddish brown. The mesonotum is black except at its extreme lateral margins. The anterior face of the propleuron is also dark tending toward black and the bases of the femora each have a more or less blackening. The posterior plate at the base of the fore wing behind the tegulæ and the three spines at the base of the abdomen are also black.

Saussure and Sichel record this species as from Lower California. The specimens which the writer has examined are also labelled Lower California.

This is the only species occurring in the territory covered by this paper in which the body is practically all ferruginous.

Triscolia fervida (Burmeister).

Scolia fervida Burm., Abh. Naturf. Ges. Halle, I, p. 4, 1853, p. 20, n. 12 ♀ Am.: Texas, Mexico.

The location of the type is unknown to the writer.

Burmeister has recorded this insect as from 14 to 16 lines long, while Saussure and Sichel have recorded the length as from 35 to 40 mm. The females which the writer has examined vary in size from 20 to 28 mm. in length and the males from 15 to 21 mm.

The body of this species is black except the segments of the abdomen behind the second. These are dark reddish brown with very little variation. The wings are uniformly fuliginous with intense metallic reflections, green at some angles, deep blue at some and purplish at others. The nervures are black. This species is one of the largest in this subfamily.

The typical examples are described by Burmeister as all black except the part of the abdomen beyond the second segment which he describes as red, red brown, or rufous. Saussure and Sichel describe a variation in which the posterior part of the second segment is also rufous.

The specimens that the writer has personally examined agree quite well with Burmeister's typical description and also agree with a good figure published in Vol. II of Cameron's Biologia, plate 12, figure 17, except that the posterior part of the second segment was always reddish brown or rufous, more evident on its under surface, and the parts described as black by Burmeister have a slight tendency when observed under the lens toward a rufous tinge. The edge of the clypeus, emargination of the eyes, edges of the mandibles, the legs especially the end segments and the spines are usually quite rufous. The edges of the segments of the abdomen described as rufous have a tendency toward darker, sometimes blackish coloring.

Burmeister records the habitat of this species as Mexico: Saussure and Sichel as Mexico and Texas. The writer has seen specimens from Mexico, Arizona, Texas and New Mexico.

Genus **Scolia** Fabricius.

Scolia FAB., Syst. Ent., 1775, p. 355, n. 11.

Generic character: Two closed cubital cells.

Type: *Scolia quadripunctata* Fab.

BIBLIOGRAPHY.

Scolia FAB., Syst. Ent., 1775, p. 355, n. 11.
Scolia LATR., Considerations generales sur l'ordre Naturael des Crustaces, Arachnides et Insects, 1810.
Lacosi GUERIN, Duperry, Voy. Coquille, Zool. II, 1830, p. 246.
Discolia SAUSSURE and SICHEL, Cat. Spec. Gen. Scolia, 1864, p. 14 (subgenus).
Lacosi SCHROTTKY, Deutsch. Ent. Zeitschr., 1910, Heft. II, p. 196.

Scolia bicincta Fabricius.

Scolia bicincta FAB., Syst. Ent., 1775, p. 356, n. 6.

Location of the type not known to the writer.

Saussure and Sichel have recorded size for the species as ranging between 20 and 25 mm. in length. In the specimens that the writer has personally examined the females range between 15 and 18 mm. in length and the males between 12 and 16 mm.

The body of this species is black except for yellowish white markings on the abdomen varying somewhat in different specimens. The wings are uniformly fuliginous with metallic reflections, blue at some angles, purplish at others. The nervures are black. This is a medium sized species.

The typical examples of this species are described by Fabricius as being black with two broad ferruginous bands at the base of the second and third segments of the abdomen. There are variations from this however. Burmeister in his work describes the spots as yellowish white instead of ferruginous and describes a specimen which has white markings on the first segment of the abdomen and the band on the third segment broken into spots.

Saussure and Sichel in their catalogue describe several specimens differing from the typical form. One of these has a yellowish white spot on the first abdominal segment, another has the bands interrupted forming spots and another has a yellowish band on the first segment and two yellowish white spots on the ventral part of the second segment.

The specimens that the writer has personally examined agree quite well with Fabricius' description except a few specimens which have the usual bands interrupted, forming spots; a few which have a narrow band of yellowish white across the dorsum of the first abdominal segment, others which have a small yellowish white mark on the postscutellum and some which have two oval spots on the ventral part of the second abdominal segment and two very small yellowish white marks on the dorsum of the fourth segment.

This species is recorded by Saussure and Sichel from boreal America. The writer has seen specimens that were collected from points that show its distribution in the United States from Texas to Massachusetts. Probably it does not occur much farther north than the latter state.

The Insect Book by L. O. Howard (plate I, No. 3), gives a good illustration of this species.

Scolia consors Saussure.

Scolia consors Saussure, Ann. Soc. Ent. France, (4), III, 1863, p. 18, ♂
Scolia amæna. Cresson, Proc. Ent. Soc. Phil., IV, 1865, p. 447, No. 3. ♂

The type of *amæna* is at the American Entomological Society rooms at Philadelphia.

Cresson describes the species as follows:

"Scolia amoena, n. sp.

"Black; orbits, two spots on prothorax, postscutellum, two large marks on third segment of abdomen, a broad band on the fourth and a narrow line on the fifth, yellow; most of legs, sides of first and second abdominal segments and most of the venter dull rufous; wings subhyaline, the costa fuscous.

"Male.—Black, clothed with short pale pubescence, rather sparsely punctured; orbits, narrow behind, yellowish, indistinct; mandibles rufous at base, antennæ as long as the head and thorax, entirely dull black. Thorax: two small triangular spots on the prothorax in front, and a transverse line on the postscutellum, yellowish; metathorax immaculate, very abrupt behind and concave; tegulæ piceous. Wings subhyaline, the costa broadly fuscous. Legs piceous, with palish pubescence; all the femora more or less rufous. Abdomen robust, black, sparsely punctured, shining, somewhat iridescent; sides of the first and second dorsal segments and the whole of the second ventral, rufous; two large, irregular, almost confluent, yellow marks on the fourth segment above; a broad, yellow band on the fourth segment, scalloped anteriorly, and on the fifth segment a narrow transverse yellow line; apical segment piceous, with three very short, subacute teeth. Length 7 lines; expanse of wings 12 lines.

"One specimen. A very handsomely ornamented species."

The writer has carefully examined the type specimen at Philadelphia and has also examined one other specimen at the same place. This last varies from the above description somewhat. The orbits of the eyes are not all yellow but there is a broad yellow mark starting within the lower part of the emargination of the eyes and extending downward along the border of the lower lobe; there is also a narrow streak of the same color behind the eye. The yellow on the postscutellum is a band instead of a line. The tegulæ are ferruginous. The coxæ are black and ferruginous in varying proportions.

The trochanters, bases of the femora and the tarsi are blackish ferruginous. The rest of the legs are light ferruginous with the broad faces of the femora lightest. The dorsum of the first segment of the abdomen has a ferruginous band and its under side is ferruginous behind. The front face of the venter of the second segment is black and the venters of the segments from the fourth backward with the dorsum of the last two segments are obscure ferruginous. The wings

are fusco-hyaline with a darker area along the costal margin including the costal end of the median, stigmal, first cubital, and radial cells and continuing beyond the cellular area nearly to the tips of the wings. The part of this darkened area within the cells is faintly yellowish, that beyond is smoky. The wings have slight purplish metallic reflections when held at certain angles. The nervures are dark ferruginous. The specimen is quite coarsely covered with whitish hairs except the dorsum of the last three segments of the abdomen where they are yellowish.

The above specimen, a male, was taken in Lower California and is now in the collection of the American Entomological Society at Philadelphia.

The type specimen was taken in Colorado.

These two specimens agree very well with Saussure's description of *consors* and the writer thinks that they will probably prove to be the same species. Because so little material could be examined, further collecting and study should prove or disprove the above conclusion. If the writer is justified in the above statement then the name *amoena* should fall and *consors* take its place. The specimens in the Philadelphia collection have been placed under the name *consors*. The writer does not know who is responsible for this.

Scolia cubensis. New species.

Type, a female from Cuba now in the collection of the American Entomological Society at Philadelphia, and the only specimen I have seen.

The specimen measures twenty-three mm. in length.

The body color is dark brown, almost nigro-ferruginous. The wings are uniformly brownish-fuliginous with metallic reflections blue at some angles, purplish at others. The nervures are brown. The specimen as a whole has a glistening appearance and is remarkably free from punctures or hairs. Most of the hairs present are deep red brown, and the punctures are shallow.

The head is more triangular than those of the other species of this subfamily and the eyes are comparatively much smaller. In other species they extend from very close to the base of the mandibles to quite near the top of the head: here they start well up from the base of the mandibles and reach only about 2-3 of the distance to the top of the head. Viewed from the side they take up only about one-third of the usual space.

The anterior lateral margins of the clypeus are set with short bristle-like yellow hair arising from an area which is obscurely yellow. The outside of the antenna beyond the third segment is quite ferruginous and the prothorax in front is rather thickly punctured and covered with long brownish hairs. The rest of the body except the venter of prothorax, pronotum, ridge of the mesopleuron, legs, and front face of the dorsum of the first segment of the abdomen is remarkably free from punctures and hairs, the top of the head, centre of the mesonotum and the central portion of the scutellum and postscutellum being particularly free. The abdomen as a whole has a slender appearance being narrow and long. At the point where the second segment of the abdomen beneath bends abruptly upward to meet the first segment and on either side of the mid line of the body there is a slight tubercular tendency. The larger spine at the end of the hind tibia is a great deal less than half the length of the first tarsal joint.

The writer has seen no other specimen like the above and no description that he has been able to find agrees with it. He has therefore described the form as a new species. He believes that when the male is studied it will be found to have distinct rounded tubercles on the ventral surface of the second abdominal segment where the segment bends upward to meet the first. This last is because of the slight tubercular tendency spoken of above in the female studied and in all species observed by the writer having these tubercles the male always has them well developed, the females only slightly or not at all.

Scolia dubia dubia Say.

Scolia dubia. Say, Boston Jour. Nat. Hist., I, p. 4, 1837, p. 364, n. 2.

The type of this species is not in existence.

Say has recorded the length of the species as four-fifths of an inch. Saussure and Sichel record the females as 22 to 25 mm. and the males as 15 to 23 mm. in length. The length of the specimens that the writer has had the opportunity to personally examine vary in the female from 15 to 22 mm. in length and the males from 13 to 19 mm.

Except for slight variations, the body of this species is black to the end of the second segment of the abdomen and the rest of the abdomen is reddish brown. The third segment of the abdomen has on each side of its dorsal surface, an ovate yellow spot. The wings are uniformly fuliginous, with metallic reflections, blue at some angles, delicately purple at others. The nervures are black.

The typical examples of this species are described by Say in the Boston Journal of Natural History, Vol. I, page 363. The body is black; head and thorax immaculate; wings dark violet blue; cubital cells two, with no appearance of more than one recurrent nervure; abdomen, first and second segments black; remaining segments ferruginous, more hairy than the others; the third segment, however, more or less tinged with blackish and with two transversely oval, a little oblique, bright yellow spots.

The specimens that the writer has personally examined agree quite well with the above description except that there is a strong tendency for variation in three directions. In one direction the specimens have the first two segments quite ferruginous. In another the whole abdomen is very black, only the edges of the segments beyond the second being ferruginous. In the other specimen the yellow spots gradually diminish until they entirely disappear. Smith in his Catalogue of Hymenopterous Insects of the British Museum describes a variety in which the yellow spots are obsolete. It is probable that this form without spots is the one that has been described by Burmeister as a separate species hæmatodes. The writer thinks that this form should be regarded as a subspecies of dubia. This would cause the name dubia to become Scolia dubia dubia; and hæmatodes, Scolia dubia hæmatodes.

Saussure and Sichel have recorded this species as found in North America; Carolina, Louisiana, Maryland, Tennessee, and Mexico. The writer has seen specimens from Mexico, Texas, Arizona, Georgia, Carolina, Virginia, Maryland, New York, and Massachusetts. Probably this species does not exist farther north than the last named state.

The Insect Book by L. O. Howard, plate I, fig. 7, gives a cut of this species.

Scolia dubia hæmatodes Burmeister.

Scolia hæmatodes BURM., Abh. naturf. ges. Halle, I., p. 4, 1853, p. 33, n. 49. ♀ ♂

The location of the type is unknown to the writer.

Burmeister describes the species as follows: Black, hairy, abdominal segments 3 to 6 rufous, wings nigro-cyanis. The length 7 to 8—^{111}♂+ ♀—Mexico.

This insect looks like and is colored and haired like Scolia dubia except that the two yellow spots on the third abdominal segment are wanting. As a whole, it is much smaller than dubia.

The writer has seen a large number of specimens that agree with this description except that one male specimen he has before him, has the sclerites of the abdomen black or slightly ferruginous and only the hairs

which clothe those segments from the second back are rufous. The venter of the second abdominal segment is usually rufous except in the darker specimens.

The length of the female ranges between 15 and 22 mm. and the males between 10 and 18 mm.

This species is fully accounted for under the variations in the description of *Scolia dubia dubia*, which see for further information on the subject.

The specimens I have seen were taken in Mexico, Texas, California, and Arizona.

Scolia flavocostalis Cresson.

? Scolia tricincta Say West. Quart. Reporter, II, 1823, p. 74.
Scolia flavocostalis. Cress., Trans. Amer. Ent. Soc., I, 1868, p. 377, no. 6, ♂

The type is in the collection of the American Entomological Society at Philadelphia.

Cresson describes the species as follows:

"*Scolia* (*Discolia*) *flavocostalis*, n. sp.

"Male.—Black, deeply and rather closely punctured, clothed with long, golden pubescence; a spot on the anterior orbits, below the emargination of the eyes, and a narrow line on lower half of posterior orbits, yellow; mandibles bright fulvous, black at tips; antennæ entirely black, robust; a spot on each side of prothorax anteriorly and another on postscutellum, yellow; scutellum with large, scattered punctures; tegulæ fulvous; wings hyaline, with an opaline reflection, costa broadly yellow to the tip of marginal cell, beyond which it is violaceous-black; anterior wing with two submarginal cells, the second receiving one recurrent nervure; legs rufo-ferruginous, clothed with yellowish hair, most of coxæ black; abdomen black, clothed with yellowish hair, especially dense on the apical margins of the segments, apex of the three basal segments more or less ferruginous; on each side of second and third segments above a yellow ovate spot, large and transverse on the third segment; fourth segment with a narrow, apical, yellow band, interrupted in the middle, and dilated laterally; apex with three short spines; venter blackish, most of the second segment ferruginous. Length 4½ lines.

"One male specimen. This may be the male of *S. Lewisii*. It is, however, much smaller."

Besides the type in the American Entomological Society's collection at Philadelphia, the writer has studied several specimens and has several before him, three of which closely agree with the description except that one has two large ferruginous spots on the dorsum of the first abdominal segment, one has a broad ferruginous band on the posterior part of the above segment and the fifth and sixth segments have an apical band of yellow, and the third has a narrow interrupted band of yellow on the fifth abdominal segment. The other specimens that have been studied

vary somewhat in the amount of yellow and ferruginous color present, especcially on the abdomen where the spots gradually enlarge to become bands, and the bands on the posterior segments are much broader. The dorsum of the median segment and the first and second segments of the abdomen gradually become ferruginous until they are practically all of that color. The writer thinks that perhaps this variation which is possibly in the direction of either *ridingsii* or *lecontei*, indicates the relationship of the three species, especially as all the specimens of *flavocostalis* seen were males. It is probable that more material will throw light on this subject.

The above specimens are all males all taken in New Mexico, except one from Texas and one from Kansas. They measure between 10 and 15 mm. in length.

Four other specimens have been studied, a female and three males, which starting with the more typical *flavocostalis*, vary toward a blacker body color and a reduction of yellow. One specimen has the body black except for a slight tendency toward ferruginous on the venter of the abdomen. The coxæ, trochanters and a small part of the femur next to the body are black. The tarsi and tarsal claws are dark ferruginous. The dorsum of the fourth segment of the abdomen has two yellow spots and the fifth segment has an obscure, interrupted, apical yellow band. One specimen has no yellow mark behind the eyes and no yellow on the fifth abdominal segment, with the body color practically all black except a slight tendency to ferruginous at the edges of the sclerites. Much more of the femur is black than in the other specimen. The female specimen has the mandibles except the tips, an obscure streak behind the eyes, the dorsum of the prothorax and the dorsum of the first abdominal segment ferruginous. The legs are nearly all ferruginous with a blackish tendency on the basal segments. The dorsum of the second and third abdominal segments have spots and the fourth and fifth have narrow yellow apical bands. The head in the above specimens except for the slight yellow marks spoken of, is all black.

These four specimens were all collected in Texas. The female measures about 11 mm., the males 9 to 11 mm. in length.

Some of the last described specimens came very near to Say's *tricincta* (Western Quarterly Reporter Cincinnati, II, 1823, p. 74, n. 2), and the writer does not agree with Cresson in placing *tricincta* under *nobilitata* but thinks further studies will probably place it somewhere in the above range. If this is correct, then *flavocostalis* will ultimately fall as a synonym of *tricincta* or become a subspecies of it.

Scolia fulviventris. New species.

This species is described from a type and five paratypes, all females; the type and two paratypes are in the collection of the American Entomological Society at Philadelphia, two paratypes in the collection of the Museum of the Brooklyn Institute and one in the collection of the Massachusetts Agricultural College.

The specimens range between eleven and fifteen mm. in length.

The ground color of the species is black with yellow markings. The wings are dark fuliginous with a darker area running along the costal border from near the end of the costal cell to the tip of the wing, and give off metallic reflections, blue at some angles, purplish at others. Most of the dorsum of the abdomen is yellow and its whole venter is ferruginous.

The head is black except a ferruginous, almost yellow spot just below the emargination of the eyes, a yellow streak behind the eyes and the middle of the anterior margin of the clypeus, which is ferruginous. It is quite thickly covered with yellowish white hairs especially thick and long in the area between the bases of the antennæ and the anterior ocellus and on the occiput. The mandibles are ferruginous, more or less streaked with black. The antennæ are black, the three basal segments glistening.

The thorax is black except two large triangular marks on the pronotum running nearly back to the tegulæ and a band covering the entire central portion of the postscutellum which are yellow. The dorsum of the mesothorax is covered with short yellow hairs, the rest of the thorax with short grey hairs. The tegulæ are black ferruginous. The legs to the end of the femur are black ferruginous, the tibia and tarsus becoming lighter. The larger spines are light ferruginous and the smaller ones yellowish. The tarsal claws are ferruginous, blackish at the tips. All of the legs are covered with rather long yellowish white hairs and the large spine at the end of the hind tibia is nearly one-half the length of the first tarsal segment.

The first two segments of the abdomen are black above, with two small yellow spots on the first and two large confluent spots on the second. The third, fourth and fifth segments above are yellow, narrowly margined with ferruginous, the yellow band on the third being slightly constricted in the middle. The sixth segment above and the venter are entirely ferruginous. All the segments are covered with short, and their edges fringed with long yellow hairs, paler beneath.

The paratypes differ from the above type in one or more of the following features. The ferruginous on the clypeus and along the inner margins of the eye varies greatly in amount. The pronotal yellow spots differ much in size. There may be a pair of ferruginous or yellowish spots on the median portion of the scutellum. The first abdominal segment above may be more or less tinged with ferruginous or may be black and without spots in either case. The spots on the second segment may not be confluent and the band on the third may be practically transformed into two spots. The distribution of ferruginous on the legs varies, sometimes extending well upward toward the body.

All the specimens were collected in Arizona.

The writer thinks that perhaps these insects may ultimately prove to be the females of *otomita*: See statement under *otomita*.

Scolia fuscipennis. New species.

Type and paratype in the United States Museum at Washington, D. C.

This species was described from two male specimens taken at Cordoba, V. C., Mexico; the type Jan. 16, and the paratype Feb. 8, 1908, by Fred K. Knab.

Type number 15092, U. S. Nat. Mus.

The ground color of this species is jet black with yellow markings on the thorax and abdomen. The wings are dark fuliginous, distinctly glossy brown, without color reflections and have a darker area along the costal cells. A light streak runs downward and backward from the end of the costal cell across the first cubital. The nervures are dark brown or black.

The head is black, deeply and rather closely punctured and is well covered with brownish hairs. The mandibles are dark ferruginous. The antennæ are black with scape and pedicle glistening, their remainder dull. Behind the eye in the type is a faint yellow spot absent in the paratype.

The thorax is black except two large marks on the pronotum running back to the tegulæ, a large mark on the upper part of the mesopleuron, two narrow longitudinal lines behind the middle of the dorsum of the mesothorax, the entire central portion of the scutellum, the elevated portion of the postscutellum slightly separated from the scutellar spot in front by a black narrow band, large marks on the lateral lobes and a small mark on the central part of the median segment above, are yellow. It is deeply and closely punctured and thickly clothed with dark

or black hairs except those which arise from the yellow spots which are pale, almost white. The legs are black, covered with black hairs and spines except the large spine belonging to the cleaning apparatus at the end of the fore femur which is ferruginous and the small pad at its base which is yellowish. The fore tarsi have a somewhat ferruginous tinge. The longer spine at the end of the hind tibia is about one-half the length of the first tarsal segment.

The abdomen is black except a broad yellow band on the dorsum of the first segment, which in the paratype is evidently a pair of confluent spots. There are also two large spots on the dorsum of the second and third, two small spots toward the sides of the fourth and two large spots on the venter of the second segment which are yellow. The abdomen is quite closely punctured and is well covered with black hairs except on the spots where they are pale. At the point where the second ventral segment bends abruptly upward to meet the first and on either side of the midline of the body are two bluntly rounded tubercles.

The paratype has no yellow marks on the mesopleuron, dorsum of the mesothorax, scutellum and middle part of the median segment and the pronotal spots are much smaller.

The length varies from 18 to 20 mm. and the body is rather slender.

Scolia guttata guttata Burm.

Scolia guttata. Burm., Naturf. Ges. Halle, I, p. 4, 1853, p. 36, n. 57, ♀
Scolia (Discolia) hecate. *W. F. Kirby*, Trans. Ent. Soc. London, 1889, p. 449, ♀ ♂ T 15 F 4.

The location of the type is unknown to the writer.

Saussure and Sichel have recorded size for this species as follows: females 22 to 35 mm. long and males 15 to 28 mm. long. Specimens that the writer has personally examined vary in length. The females range from 21 to 28 mm. in length and the males from 15 to 23 mm. in length.

The body of this species is black except for yellow markings, varying in number and size on different individuals. The wings are uniformly fuliginous with metallic reflections, blue at some angles, purplish at others. The nervures are black in some specimens and ferruginous in others. This species is one of the largest of this subfamily.

The typical examples of this species are described by Burmeister as having a round golden spot on each side of the second and third segments with small round golden spots on the underside of the fourth segment. There is considerable variation from this however, as is stated by Cameron in the Biologia. He says that this is a very variable

species not only in size but in coloration. He describes several specimens showing a gradation in variation from yellow markings on the clypeus, pronotum, mesopleura, scutellum, postscutellum, first, second, third, fourth and last abdominal segments to two specimens which had no yellow at all. He says the most common form is the one with the maximum yellow upon it and that the male examples do not show much variation. They have either two yellow marks on the first and second abdominal segments or two on the second segment only.

The specimens that the writer has personally examined agree quite well with Burmeister's typical description except that the yellow markings on the fourth abdominal segment would hardly be regarded as being on the under side of the segment though well down on the side. At the point where the second segment of the abdomen bends abruptly upward to meet the first ventral segment and on either side of the midline of the body are two bluntly rounded tubercles quite large in some specimens especially in the males, smaller and almost disappearing in the females.

Between this species and *azteca* the writer has been able to find no structural difference and it is his opinion that the two forms can be separated only by the color, *azteca* being entirely black and *guttata* as described above. This color distinction has been easily drawn in all the specimens observed and so the writer has chosen to consider the above as two forms, with *azteca* a subspecies of *guttata*. This causes the name *Scolia guttata* to be changed to *Scolia guttata guttata* and *Scolia azteca* to *Scolia guttata azteca*.

Saussure and Sichel have recorded this species from Mexico.

The specimens that the writer has seen came from the plains of Mexico and from the southern part of Texas.

Scolia guttata azteca Sauss.

Scolia azteca Sauss., Rev. et Mag. Zool, (2), (IX), 1857, p. 281.

Location of the type unknown to the writer.

Saussure records the length of the species as 27 mm. The length of the specimens that the writer has had the opportunity to examine varies in the female from 18 mm. to 29 mm. The males measure about 20 mm.

The color of this species is deep black. The wings are uniformly fuliginous throughout with metallic reflections, blue at some angles, purplish at others and greenish at still others. It is one of the larger species of the group.

The typical examples are described by Saussure as follows: The female on the average of a deep black, shining, with black hair. Head and thorax very finely punctured; the metathorax deeper than the rest, abdomen irregularly punctured, wings deep black with bluish or steely reflections. The nervures are black. Males are very densely punctured.

The specimens that the writer has studied agree with this description except that the wings held at some angles have a greenish reflection as well as the bluish and purplish reflections spoken of above. At the point where the second ventral segment of the abdomen bends abruptly upward to meet the first ventral segment and on either side of the midline on the body is a bluntly rounded tubercle quite large in some specimens especially in the male, smaller and almost disappearing in some of the females.

Saussure and Sichel in their catalogue give the habitat of the species as Mexico. All specimens that the writer has seen came from Mexico.

So far as structure goes the writer has been unable to separate this species from *guttata* Burmeister. He is of the opinion that aside from the color they cannot be separated and for this reason he would consider this form a subspecies of *guttata*. See what already has been said on this subject under *guttata*.

Scolia inconstans Cresson.

Scolia inconstans CRESS., Proc. Ent. Soc. Phila., IV, 1865, p. 446, No. 2.

The type is in the collection of the American Entomological Society at Philadelphia.

Cresson describes the species as follows:

Scolia inconstans, n. sp.

"Obscure ferruginous; head, antennæ and most of thorax blackish; sides of prothorax with a large luteous spot; third segment of abdomen with a yellow spot; wings subhyaline, the costa yellowish, with a dark streak beyond the marginal cell.

"Male.—Head black, with yellowish pubescence; the orbits, more or less interrupted, yellowish; anterior margin of the clypeus, and the mandibles, except tips, luteous; antennæ nearly as long as the head and thorax, dull black, somewhat brownish beneath. Thorax blackish, with rather dense, prostrate, yellowish pubescence, and close, rather deep punctures; on each side of the prothorax a large luteous spot; lateral margins of the mesothorax obscure testaceous; pleura sometimes with a ferruginous stain; postscutellum luteous, and sometimes the scutellum is tinged with the same color; metathorax black, sometimes rufo-piceous, on each side a large rufous or ferruginous spot or stain,

the posterior face abruptly truncate and somewhat concave; tegulæ ferruginous. Wings hyaline, slightly dusky on the broad apical margins, and with a slight violaceous reflection; the costa yellowish, especially about the marginal and submarginal cells, and beyond the former a blackish streak extending to the tip of the wing; nervures fuscous. Legs ferruginous, with yellowish pubescence. Abdomen obscure ferruginous, punctured, shining, iridescent, clothed with yellowish pubescence, more dense on the apical margins of the segments; basal segment rounded at base and more closely punctured than the following segments, the apical margin slightly contracted; third segment with a large, transverse, yellow macula on each side, and the apex, of the fourth segment is narrowly margined with yellowish; in one specimen the spots on the third segment are very large, while the two basal segments have a small obsolete, luteous stain on each side at base, and the fourth segment has an angular yellow mark on each side; the base of the third, fourth, and fifth segments are sometimes more or less blackish; the apical segment is armed at tip with three long acute spines, the central one the longest; ventral segments ferruginous, with their base more or less blackish. Length 6—6¼ lines; expanse of wings 11—11½ lines.

"Two specimens. This species has some resemblance to S. dubia Say, in the markings of the third abdominal segment, but is otherwise very distinct."

There are two specimens in the collection at Philadelphia both marked types. The writer has examined both and has one before him marked type number 568–2 which varies a little from the above description. The yellow mark in front of the eyes starts well within the emargination, is quite broad and extends downward along the lower lobe of the eye. There is a narrow yellow streak behind the eyes. The antennæ are slightly ferruginous beneath. The body color of the thorax is black but all the sclerites have a marked tendency to be tinged with ferruginous. The pronotum has two large triangular spots which are joined together in front by a narrow darker band and extend back to the tegulæ. The postscutellum has a broad yellow band and the tegulæ are light ferruginous almost flavous. The median or last segment of the thorax, has a ferruginous spot on the dorsal surface of each side lobe and on its central part a slight tinge of the same color. The wings are subhyaline with a stained area along the costal border. The costal, end of the media, stigmal, first cubital and radial cells with a small portion just beyond the radial are light yellow and covered with short yellow hair. The area from just beyond the radial to near the end of the wings is slightly smoky and gives a light purplish metallic reflection at some angles. The nervures are light ferruginous or flavous. The base of each segment of the abdomen has a black band and there

are two large transverse oval spots on the third with a narrow line at the end of the fourth segment which are yellow. All the rest of the abdomen is ferruginous. The length of this specimen is about 12 mm.

The two specimens that the above description was written from were collected in Colorado. The writer has seen no other specimens like these in the Philadelphia collection, although he has seen several collections from that or adjacent territory. It is the writer's opinion that further collections from Colorado would throw much needed light on the identity of this species.

Scolia lecontei Cresson.

Scolia lecontei CRESS., Trans. Am. Ent. Soc., I, 1868, p. 376, n. 5 ♀.

Type in the collection of the American Entomological Society at Philadelphia.

Cresson describes this species as follows:

Scolia (*Discolia*) *Lecontei*, n. sp.

"Female.—Head black, sparsely punctured, a large rufous spot on the front, extending from the lower ocellus to and including the space between the antennæ, and also the emargination of the eyes; posterior orbits, clypeus and mandibles, except tips, rufous; occiput clothed with a dense golden pubescence; antennæ short, robust, black, scape dull rufous; thorax with deep, rather close punctures; prothorax, except its anterior middle, extreme lateral margin of mesothorax, tegulæ and scutellum rufous, the latter flat, with a few scattering, deep punctures; postscutellum bright yellow; rest of thorax black, sparsely clothed with golden pubescence, more dense on prothorax in front, and on metathorax, the prominent, lateral lobes of the latter with an obscure rufous spot; wings fusco-hyaline, strongly tinged with yellowish, especially along the costa to the tip of the marginal cell, beyond which it is violaceous-black; both wings have a beautiful purple reflection, especially towards the apical margin; anterior wing with two submarginal cells, the second receiving one recurrent nervure; legs rufo-ferruginous, clothed with yellowish hair, most of coxæ black; abdomen rufo-ferruginous, sparsely punctured, shining, second to fifth segments above stained more or less with blackish, second and third segments above with a large, ovate, bright yellow spot on each side, nearly meeting on the disk, those on the third segment more transverse and regular; fourth segment with a transverse yellow band at tip; fifth segment with a subobsolete, narrow yellowish stripe near the tip, sub-interrupted in the middle; apical margins of all the segments with a dense, rather long fringe of yellowish hairs; venter dull ferruginous, the third segment black at base. Length 6 lines.

"One female specimen. At first sight this species has much the appearance of *Elis Xantiana* Sauss."

The writer has one specimen before him which agrees very closely with the above description except for an obsolete yellow spot behind the eyes. Study has been made of other specimens that vary somewhat from the above. Two of these have no yellow marks on the fourth and fifth segments of the abdomen and the whole insect has a dark rufous to blackish appearance, showing a tendency to vary toward a loss of yellow and ferruginous on the abdomen especially and has a general darker appearance as a whole. Probably these forms stand somewhere between the typical *lecontei* and Say's *tricincta*.

The writer has seen several other specimens which show a gradual increase in the yellow and ferruginous from the type to a specimen which has the yellow mark behind the eyes and the spots on the prothorax much larger while the spots on the second segment are very large, those on the third have become a broad band and there are two wide bands on the fourth and fifth. Possibly this variation of increasing yellow and ferruginous is in the direction of *ridingsii*.

The specimens that the writer has seen are all females measuring from 12 to 15 mm. in length and were all collected in Texas except one which was taken in New Mexico.

No one specimen has all the marks spoken of at their extreme development as indicated. The head of this species has the occiput quite black and this color encroaches downward upon the upper part of the frons. The rest of the face is ferruginous.

It is probable that further collection will throw much needed light on the relation of *ridingsii*, *lecontei*, *tricincta*, and *flavocostalis*, which seem in many respects to be closely allied.

Scolia monticola Cameron.

Scolia monticola CAMERON, Biol. Centr. Amer., P. 112, 1873, Hymen. II. p. 223, n. 3, ♀ ♂.

The type is probably in the British Museum.

Cameron describes the species as follows: "Deep black, shining; the head and thorax densely covered with short, thick, black pubescence; the back of the abdomen densely covered with short, the ventral surface with long, black hairs. The head covered with large, distinctly separate punctures; the mesonotum and scutellum coarsely and strongly punctured, somewhat smaller than those on the mesonotum. Abdomen closely and finely punctured; the hair on the apical segments above long, black and thick. Legs deep black, the spines and hair also black. Wings deep violaceous-blue. The male is similarly colored and clothed, the antennæ in this sex bearing a close microscopic greyish pile, which gives them a paleish appearance. Size of the female 18 to 20 mm., of male 15 to 18 mm."

At the end of the above description Cameron says: "It is obvious that the insect is nearly related to *Scolia azteca;* the latter, however, differs from *Scolia monticola* in having" (from this point to the end of the paragraph is a translation) an obtuse median tubercle at the base of the second ventral segment which is subtruncate. In the female this tubercle is minute almost disappearing. In the male it is larger, somewhat broader transversely emarginate in the middle and subcarinate on either side.

The writer has but two specimens which he could consider as this species. They measure about 13 mm. in length and agree well with the above description. The point of difference in the presence or absence of the tubercle on the venter of the second abdominal segment is borne out. These specimens do not have it. The whole specimen is black and the body except the front of the head is thickly punctured and haired. A part of the frons starting just below the bases of the antennæ and continuing upward between them, then gradually widening to a straight transverse line which if continued would intercept the eyes at the upper edges of their emarginations, is raised above the rest of the face enough to allow for the insertion of the antennæ in its sides instead of in the usual depressed space. The part of this raised portion posterior to the bases of the antennæ is closely and deeply punctured. The rest of the face is sparsely indented with rather deep punctures. Starting at a point just posterior to the larger ocellus a continuous ridge passes downward and outward across the frons to a point within the emargination of the eyes. The wings are fuliginous with a darker area along the costal border, and they have conspicuous metallic reflections, blue at some angles, green at some and bright purple at others with perhaps a slight tendency toward magenta in places.

This species is easily distinguished from others in this subfamily by the peculiar elevation of the portion of the frons spoken of above. This is not referred to by Cameron and therefore possibly the insect here described is not *monticola*. If it should prove not to be *monticola* it may be given the name *nigrescens*.

The two specimens are now in the American Museum at New York City. Locality unknown. They agree quite closely with a specimen in the American Entomological Society collection at Philadelphia marked *nigrescens* type, undoubtedly a manuscript name. More material should throw needed light on this species.

Scolia nobilitata Fabricius.

Scolia nobilitata FABRICIUS, Systema Piezatorum, 1804, p. 244, n. 32.

Smith in his catalogue of the British Hymenoptera, page 206, records a Fabrician specimen in the Museum of the Linnaean Society of London.

Burmeister has recorded size for this species as 5 to 8 lines. The length of the specimens that the writer has had the opportunity to examine vary in the female from 12 to 16 mm., in the males from 8 to 12 mm.

In comparison with the group as a whole this is a small species. The body is black and there are always four yellow spots on the abdomen, the second and third segments each having two. In a large number of cases there is a ferruginous tinge to the abdomen and the yellow markings on the body are encroached upon by this coloring. The wings are uniformly fuliginous with violet reflections at some angles, blue at others. The nervures vary from dark ferruginous to quite black.

Fabricius described the type as hairy and black, with two yellow spots on the prothorax and the scutellum yellow, base of the abdomen ferruginous and bearing four yellow spots.

Head black, antennæ cylindrical, thorax globose, black, prothorax has two yellow spots, postscutellum yellow. Abdomen hairy and black, the three basal segments obscurely brick red. Segments two and three each with two yellow spots. Legs ferruginous, femora black.

The Insect Book by L. O. Howard (plate I, fig. 2) gives a good cut of a female of this species.

The specimens that the writer has examined agree quite well with Fabricius' description and also with the illustration given by Howard, except for slight variations. The average female has a black head except for the mandibles and the underside of the antennæ. The mandibles are ferruginous, becoming almost black toward their tips and the antennæ though mainly black have a ferruginous tinge, particularly beneath.

The thorax is black except for two yellow triangular spots on the pronotum, a large yellow mark on the postscutellum and the tegulæ which are ferruginous. Coxæ and trochanters black, femora partly black, partly ferruginous and the remaining portions of the legs ferruginous except the tips of the claws which are black, spines ferruginous. Wings uniformly fuliginous, with blue and violet reflections. The ground color of the abdomen is black but there is a tinge of ferruginous especially in the first three segments, more generally present in the first.

The second and third segments have on each side of their dorsal surface a large oval yellow spot.

The writer has seen several specimens which varied from the above in that although the ground color of the body was black, a great part of the head, edges of the sclerites of the thorax, scutellum, dorsal part of the median segment, nearly all of the legs and the dorsum of the first segment of the abdomen were ferruginous while the rest of the abdomen was deeply tinged with the same color. A few specimens had two small yellow spots on the first segment of the abdomen and a yellow streak behind the eyes. The above description with the same variations will apply to the male. The writer has also seen a male with two small yellow marks on the fourth segment of the abdomen. The antennæ of the male are entirely black. The variety ***maculata*** Guerin, of this species the writer has been unable to recognize in the material available.

Fabricius records this insect from Carolina, Burmeister from North America. The writer has seen specimens from Florida, Georgia, North Carolina, Pennsylvania, Virginia, Texas, Long Island, N. Y., and Arizona.

Scolia otomita Saussure.

Scolia otomita Sauss. Am. Soc. Ent. France, (3), VI, 1858, p. 223, No. 35 ♂.

The location of the type is unknown to the writer.

Saussure and Sichel describe the species in their catalogue. The following is a translation of the description:

Male.—Small, black, greyish haired, abdominal segments three to five with yellow fascia. Length 12½ mm.; wings, 10 mm.

Small, black, densely punctured, covered with grey hair. A small yellowish silvery spot on each side of the face outside of the clypeus. Two yellow spots on the prothorax and postscutellum yellow. The tegulæ are brown, segments three, four, and five of the abdomen bear a yellow band which is margined only at the fifth. The smaller margins of the segments brown. All the segments of the abdomen strongly ciliated with tawny yellow hair. The end of the abdomen brown. Legs black, clothed with grey hairs. Tibial spines ferruginous. Wings transparent, nervures brown, radial cell subtriangular, large and truncate. Habitat Mexico.

The writer has seen but one specimen, a male, which he could consider as this species. This specimen measures 13 mm. in length. Its ground color is black. The wings are fusco-hyaline, a much darker portion extending from within the end of the median cell along the costal border almost to the tip of the wing; metallic reflections are present, blue at some angles, purplish at others. The nervures are

black. The head is black except a narrow streak extending downward from the emargination of the eyes along the edge of their lower lobes and a narrow line behind the eyes which are yellow. The mandibles except their edges and tips are ferruginous. The antennæ are black, tinged with ferruginous beneath. The thorax is black except two triangular yellow marks on the pronotum and a transverse yellow band on the postscutellum. The legs are black with a very faint ferruginous tinge and their spines are ferruginous. The first and second segments of the abdomen are black or ferruginous black and the venter of second is slightly tinged with ferruginous. The dorsum of each of the other segments of the abdomen is yellow, their margins ferruginous-brown except the last which is nearly all of this color. The undersides of the last named segments are ferruginous-brown, faintly mottled with yellow. The edges of the segments behind the first are fringed with greyish yellow hairs, with the remainder of the body and legs sparsely clothed with grey hairs except on the clypeus where they are yellowish ferruginous.

The above description was made from a specimen now in the collection of the American Entomological Society at Philadelphia. It was taken in Nevada.

It may be unsafe to draw any conclusions from the study of a single specimen. The writer is of the opinion however that the specimen here described though differing in a few minor details, is *Scolia otimita* Saussure, and that the females described as *Scolia fulviventris* will ultimately prove to be the females of this species.

Scolia ridingsii Cresson.

Scolia ridingsii. CRESS., Proc. Ent. Soc. Phila., IV, 1865, p. 445, No. 1 ♀.

The type is in the collection of the American Entomological Society at Philadelphia.

Cresson describes the species as follows:

"*Scolia ridingsii*, n. sp.

"Ferruginous; sides of prothorax, scutellums, and a large spot on each side of four basal segments of abdomen above, luteous; wings deep yellow, the apical margins broadly fuliginous with a beautiful violaceous reflection, and a dark cloud beyond the marginal cell.

"Female.—Ferruginous, clothed with fulvous or golden-yellow pubescence, closely and rather deeply punctured; the sinus of the eyes and the outer orbits, sometimes luteous, and in one specimen extending entirely across the occiput; mandibles piceous at tips; antennæ piceous, the two or three basal joints ferruginous. Thorax: sides of the prothorax, a spot on the pleura, scutellum and postscutellum, and a spot on each side of the metathorax, sometimes much reduced, luteous; the

scutellums with large, deep, scattered punctures; metathorax short, broad, more finely punctured than the rest of the thorax, abruptly truncate and somewhat concave behind. Wings: the superior pair deep yellowish-hyaline, the apical margin broadly fuliginous with a beautiful violaceous reflection; beyond the marginal cell a broad blackish cloud extending to the tip of the wing; nervures honey-yellow; posterior wings fuliginous, with a purplish reflection, the base subhyaline. Legs ferruginous, with golden-yellow pubescence, the tibiæ tuberculate above, the tarsi spinose. Abdomen sparsely punctured, faintly iridescent; on each side of the four basal segments above, a rounded luteous spot; sometimes slightly confluent; the spots on the first and fourth segments smallest, and when confluent, they form a rather broad transverse band; those on the second and third segments are large, the former round and the latter rather transverse; all the segments densely fringed with fulvous pubescence; the apical segment densely clothed with dense, prostrate, fulvous pubescence; venter paler ferruginous, the second and third segments obsoletely stained with obscure luteous, the basal segments deeply contracted. Length 8 lines; expanse of wings 13½ lines.

Two specimens."

The writer has before him three specimens, one marked type 565–2 and has carefully studied four other specimens at Philadelphia, all females. These agree well with the description except the marking described as luteous which the writer would prefer to term yellow. The costal, subcostal and basal nervures of the front wings are ferruginous. The rest of the nervures except the subdiscoidal nervure which is bluish, are yellow. The parts of the fore wing not inclosed within the cells are slightly fuliginous with a much darker area reaching from near the ends of the radial and from within the submarginal, to near the tip of the wing. A streak running along the frenal fold is quite fuliginous. These last areas have metallic reflections, blue at some angles, purplish at others. The hind wings are somewhat fuliginous with slight purple metallic reflections. The end of the fifth abdominal segment has a narrow yellow band and the venter of the first segment is obsoletely stained with yellow.

The other two specimens that the writer has before him differ from the above in that the antennæ beyond the three or four basal segments are quite black above but faintly ferruginous beneath. The yellow band behind the eyes and reaching across the occiput is interrupted in the middle with ferruginous. A band along the parapsidal grooves is black and the anterior edge of the mesopluron is darker than the plate as a whole. The tips of the tarsal claws are ferruginous to black. The yellow marks on the last or median segment of the thorax are obscure in one specimen and wanting in the other.

The head in the above described forms is yellowish ferruginous.

The type specimen and four others were taken in Colorado. The other two whose differences from the type have just been described were taken in California and Lower California. They are all in the collection of the American Entomological Society at Philadelphia. These specimens measure about 15 mm.

The writer also has two specimens before him, one from the United State National Museum, collected in New Mexico and the other from Philadelphia collected in Texas, which vary from the above specimens toward *lecontei*, but standing closer to *ridingsii* than to the other. They vary from *ridingsii* in having the part of the head behind the emargination of the eyes and a large part of the thorax quite black. The specimen at Philadelphia has two yellow spots on the pronotum nearly obsolete and the three spots on the dorsum of the median segment are ferruginous. The dorsum of the second segment of the abdomen has very small round black spots on its sides and the anterior edges of the third and fourth segments are very dark, almost black. The abdomen of the specimen from the United States National Museum has only the small black spots on the sides of the second segment of the abdomen above.

The writer thinks that perhaps further collecting in the above territory may result in uniting *ridingsii* and *lecontei*.

Scolia vintschgaui Dalle Torre.

Scolia saussurei CAMERON, Biol. Cent. Amer., p. 112, 1893, Hymen. II, p. 226, n. 10 ♀; Pl. 12, f. 9.

Scolia vintschgaui Dalla Torre, Cat. Hym., VIII, 1897, p. 187, (new name).

The type is probably in the British Museum.

A good figure of this species is given in Cameron's Biologia Centrali-Americana, plate 12, fig. 9. The name *saussurei* used by Cameron, according to the rules of the International Zoological Congress will have to give way to *vintschgaui* because *saussurei* had been already used in 1864 by Saussure and Sichel for an African species of *Scolia*.

Cameron describes the species as follows:

"Black, hairy, two spots on the pronotum and the postscutellum yellow, abdomen bifasciate with yellow, prothorax reddish haired, wings smoky. Length of female, 14 mm.

"Head coarsely punctured; the front ocellus in a deep round pit. Mesonotum coarsely and strongly punctured all over; scutellum punctures larger and more widely separated. Median segment, mid portion finely, lateral portions strongly, punctured. Head and thorax covered

with fulvous hair, that on the median segment being longer and paler. Yellow marks on the pronotum somewhat triangular. Abdomen above covered with long fulvous hair, the fifth and six densely covered all over with fulvous golden hair; basal segments finely punctured, the segments fringed with pale golden hair, third segment for the greater part yellow, the back basal band projecting in the middle; fourth segment is yellow, except for a very black apical band. The legs are black, covered with long, pale hair; tarsal spines rufous. Wings are fusco-hyaline, the fore margin much darker, the dark band extending from the base to near the apex; the costa dark testaceous."

The writer has seen but one specimen, a female, which he could regard as this species. This specimen measures 14 mm. in length. Its ground color is black. The fore wings are fusco-hyaline with a darker streak extending from near the base of the first discoidal cell outward a short distance behind the costa and extending about halfway from the end of the radial to the apex where it gradually disappears. The area between this band and the costa has a distinct yellowish tinge. The wings have metallic reflections, blue at some angles, purple at others. The nervures are black ferruginous. Head, all black except mandibles which are partly ferruginous, antennæ entirely black, thorax all deep black except two triangular spots on the pronotum and a transverse band on the postscutellum which are yellow. Legs black, the tarsi particularly the front pair with a tendency toward ferruginous, spines light ferruginous. Abdomen black except two very small spots on the second segment, broad bands on the dorsum of the third, fourth and fifth, which are yellow. The dorsum of the last segment is black. The dorsum of the third, fourth, and fifth are narrowly margined with black, both in front and behind. The dorsal plate of the mesothorax, posterior dorsal margins of the second, third, fourth and the dorsal and ventral posterior margins of the fifth segments of the abdomen are fringed with yellow hair. The dorsal surfaces of the segments from the second segment back are covered with yellow hair. The rest of the specimen is sparsely covered with whitish hair.

The specimen was collected at Guadalajara Jal. Mexico. It is a female and is now in the collection of the American Entomological Society at Philadelphia.

This is the only specimen seen by the writer, which appears to agree with Scolia vintschgaui and this one differs slightly in distribution of color. More are needed in order to determine the amount of color variation in this species.

UNIDENTIFIED SPECIES.

I am unable to recognize the following species, which have been described as having been taken within the geographical limits covered in this paper, though I have in some cases ventured to guess at what they may be. The name given is that under which the description was published.

SCOLIA ANCEPS Saussure.

Scolia anceps SAUSS., Ann. Soc. Ent. France, (3), VI, 1858, p. 221, n. 32, ♂.

I think from Sassure's description that this species is the one that Burmeister has described as *haematodes*.

SCOLIA BIDENS.

Sphex bidens L., Syst. Nat., Ed. XII, I, 1767, p. 943. ♀ ♂ Eur. mer.; Afr. bor.; (Am. bor.).

This is a well known Old World species and as there is no recent record of its capture in America it is probably an erroneous record and may safely be omitted from the American faunal list. Saussure and Sichel in their Cat. Spec. Gen. *Scolia* say it is recorded from North America (by error?).

SCOLIA BIFASCIATA Swederus.

Sphex (*Scolia*) *bifasciata* SWEDERUS, Svensk. Vet. Akad. Handl. VII, 1787, p. 281, n. 35. New York.
Scolia bifascata GMELIN, Linne, Syst. Nat., Ed. 13, I, 5. 179a, p. 2738, n.26.

I have not seen the original description by Swederus but only that of Gmelin which I assume is a copy. From this I am unable to determine anything in regard to this species.

SCOLIA MEXICANA Saussure.

Scolia mexicana SAUSS., Ann. Soc. Ent. France, (3), VI, 1858, p. 213, n. 23, ♀. Mex.

From Saussure's description I am unable to recognize this insect, but it is probably only a variation of *Scolia guttata guttata*.

SCOLIA NOBILITATA variety MACULATA Guerin.

Scolia maculata GUERIN, Duperry, Voy. Coquille, Zool. II, p. 2, 1830, p. 255 ♀.
Scolia nobilitata var *maculata* Sauss. and Sichel, Cat. Spec. Gen. Scolia, 1864, p. 132.

I have not seen Guerin's description but Saussure and Sichel in their catalogue give what I suppose is a copy of it. From this the writer has been unable to draw any conclusions in regard to *maculata*.

GENERAL INDEX TO SCOLIINÆ.

abdomen..... 304
Analytical keys..... 312
antennæ..... 300
bulb..... 300
Bibliography—
Scoliinæ..... 311
Scolia..... 315
Triscolia..... 313
cheek..... 299
claws..... 309
Climatic variation..... 311
clypeus..... 298
Collections..... 294
Colors..... 311
coxa..... 309
External anatomy..... 298
Explanation of plates..... 340
eyes..... 298
femur..... 309
filament..... 300
first segment of abdomen..... 305
fore wings..... 308
frenal fold..... 308
frenal hooks..... 308
frons..... 299
Geological distribution..... 311
Habits..... 297
head..... 298
History..... 295
hind wing..... 308
Introduction..... 293
labrum..... 299
last segment of abdomen..... 305
female..... 306
male..... 305
legs..... 309
literature..... 293
mandibles..... 300
maxillary palpi..... 300
median segment..... 303
mesonotum..... 301
mesosternum..... 302
mesothoracic pleuron..... 302
metapleuron..... 303
metasternum..... 303
mid coxæ..... 309
neck..... 301
Nomenclature of wing..... 307
venation..... 307
cells..... 307
ocelli..... 299
parapsidal grooves..... 301
pedicle..... 300
petiole..... 305
postscutellum..... 302
pronotum..... 301
prothorax..... 301
pulvillus..... 309
scape..... 301
scutellum..... 301
Sex differences..... 310
spines..... 310
end of abdomen..... 304
legs..... 310
spiracle..... 304
striæ..... 308
subalar..... 309
Synoptic tables..... 312
tarsal comb..... 310
tarsus..... 310
tegulæ..... 308
thorax..... 301
tibia..... 309
trochanters..... 309
Unidentified species..... 338
wings..... 307

INDEX TO SPECIES AND GENERA OF SCOLIINÆ.

amœna..... 317
anceps..... 338
badia..... 314
bicincta..... 316
bidens..... 338
bifasciata..... 338
consors..... 317
cubensis..... 318
dubia dubia..... 319
dubia hæmatodes..... 320
fervida..... 315
flavoscostalis..... 321
fulviventris..... 323
fuscipennis..... 324
guttata guttata..... 325
guttata azteca..... 326
hecate..... 325
inconstans..... 327
lecontei..... 329
mexicana..... 338
monticola..... 330
nobilitata..... 332
nobilitata var. maculata..... 338
otomita..... 333
ridingsii..... 334
Scolia..... 315
tricincta..... 322
Triscolia..... 313
vintschgaui..... 336

INDEX TO LETTERING OF PLATES.

a	anal cell.	md	mandible.
a_1	anal nervure.	mn	mesonotum.
ab	abdomen.	mp	metapluron.
ap	apical cell.	ms	median segment.
b	bulb.	mt	metatergum.
bn	basal nervure.	n	neck.
c	costal nervure.	o	ocellus.
c_1	costal cell.	p	parapsidal groove.
cc	coxal cavities.	pc	anterior coxa.
cl	clypeus.	ped	pedicle.
cu	cubital nervure.	pe	prothoracic episternum.
cu_1	first cubital or submarginal cell.	pn	pronotum.
cu_2	second cubital or submarginal cell.	pt	antennal pit.
cu_3	third cubital or submarginal cell.	re_1	recurrent nervure.
cu_4	fourth cubital or submarginal cell.	s	spiracle of median segment.
d	discoidal nervure.	sc	subcostal nervure.
d_1	first discoidal cell.	scp	scape.
d_2	second discoidal cell.	sct	scutellum.
d_3	third discoidal cell.	sd	subdiscoidal nervure.
e	eye.	sm	submedian cell.
em	externo-medial nervure.	sp	spine.
ep_3	mesothoracic episternum.	st	sting.
f_1	filament.	t	tegulæ.
ff	frenal fold.	tc	first transverse cubital nervure.
fh	frenal hooks.	tc_1	second transverse cubital nervure.
m	radial or marginal cell.	tc_2	third transverse cubital nervure.
m_1	radial or marginal nervure.	tm	transverse medial nervure.
mc	median cell.	wc	wing cleft.

EXPLANATION OF PLATES XXII–XXIII.

The figures were drawn with the Camera Lucida.

PLATE XXII.

Fig. 1. Dorsal view of the last segments of a female Scolia guttata.
Fig. 2. Ventral view of the last segments of a female Scolia guttata.
Fig. 3. Dorsal view of the last segments of a male Scolia dubia.
Fig. 4. Ventral view of the last segments of a male Scolia dubia.
Fig. 5. Antenna of a female Scolia dubia.
Fig. 6. Antenna of a male Scolia dubia.
Fig. 7. Front view of the head of a male Scolia dubia.
Fig. 8. Front view of the head of a female Scolia dubia.

PLATE XXIII.

Fig. 9. Anterior wing of Triscolia fervida.
Fig. 10. Anterior wing of Scolia dubia.
The missing guide line from re_1 in this figure should lead to the nervure joining d and cu.
Fig. 11. Posterior wing of Scolia dubia.
Fig. 12. Side view of the thorax of Scolia dubia.

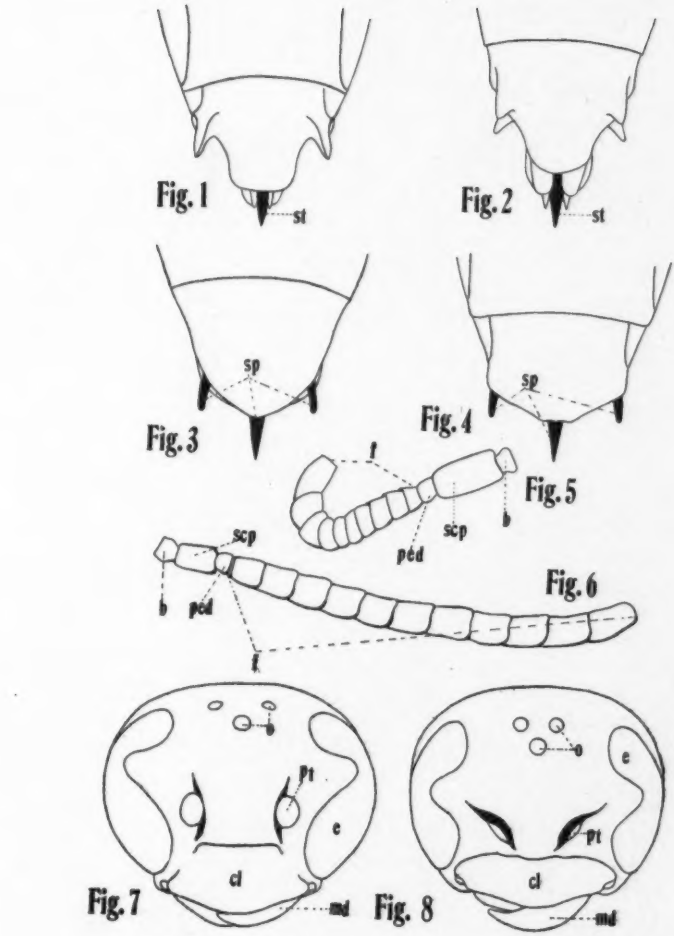


Fig. 1
st
Fig. 2
st
sp
Fig. 3
sp
Fig. 4
f
Fig. 5
scp
ped
b
scp
ped
b
f
Fig. 6
e
pt
cl
md
Fig. 7
e
pt
cl
md
Fig. 8

O. C. Bartlett.

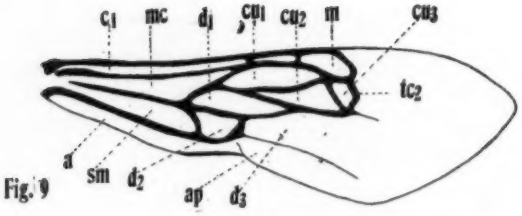


Fig. 9

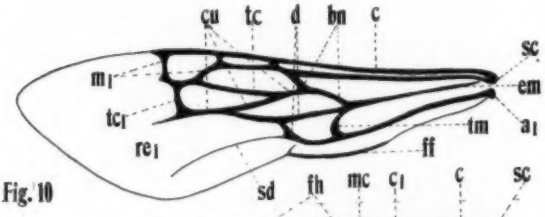


Fig. 10

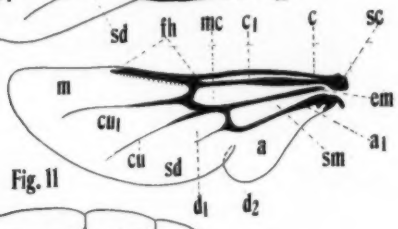


Fig. 11

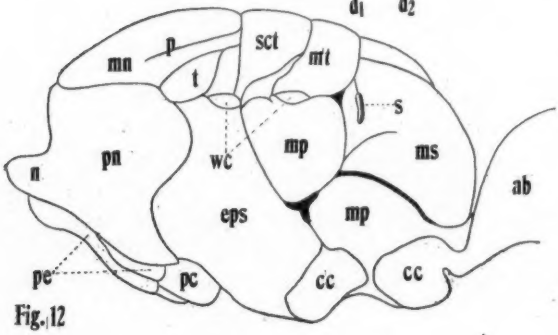


Fig. 12

O. C. Bartlett.

NEW NEOTROPICAL TIPULINÆ (TIPULIDÆ, DIPT.).

CHARLES P. ALEXANDER, Ithaca, N. Y.*

The following species are included in four collections that I have had for study, received from the following sources: The American Museum of Natural History, including the Williston collection, received through Mr. J. A. Grossbeck; the Cornell University Collections consisting of Mr. H. S. Parish's extensive Brazilian material, through Dr. J. C. Bradley; the United States National Museum Collections, through Mr. Frederick Knab, and a small lot received from Staudinger-Bang-Haas and now in my cabinet. I wish to thank the above named gentlemen for the loan of this and other interesting crane-fly material.

The *Tipulini*, containing the great genera *Tipula* and *Pachyrhina*, is, in any region, in a very chaotic condition. The genus *Tipula* with its hundreds of described species has become so unwieldly as to be almost unusable. In the Neotropical fauna there are described up to the date of this writing, 46 species of *Tipula* and 12 of *Pachyrhina*. Some of these, however, are undoubtedly synonomous (as *moniliformis* Röder and *ornaticornis* v. d. Wulp). The future student of the *Tipulini* should make it a point of obligation to his fellow students to describe in detail, and figure if possible, the genitalia of the male and female. Mr. R. E. Snodgrass (Trans. Am. Ent. Soc.; Vol. XXX, pp. 179–236) laid a firm foundation for the study of the male hypopygium, and American authors are using this character to some considerable extent. As an example of a splendid revision of a genus of this tribe, I will cite Mr. M. P. Riedel's excellent paper on the Palæarctic Pachyrhinæ.†

It is probable that hypopygial characters can never be made the main basis of subdivision into groups because of the great differences in closely-related species and the consequent tendency to separate forms that are closely allied. At present it seems as if Schummel's old division of species into groups on wing-pattern is the best for main group characters. Nevertheless, hypopygial characters are so constant and so extremely important that it would be impractical to ignore them.

*Entomological Laboratory, Cornell University.

†Deutschen Entomol. Zeitschr.; Vol. for 1910, p. 409–437, 4 fig.

I have before me male specimens of the following species which I expect to characterize more fully in the third part of my "Synopsis of the Neotropical Tipulidæ."

Pachyrhina nigrolutea Bellardi.
Macromastix chilensis Philippi.
Tipula albifasciata Macquart.
Tipula craveri Bellardi.
Tipula edwardsi Bellardi.
Tipula microcephala v. d. Wulp (which seems to belong to *Holorusia* Lw.). This name is preoccupied by *T. microcephala* Big. (1858), and I rename the South American species, *Tipula vanderwulpi* n. n.
Tipula monilifera Loew.
Tipula moniliformis Röder.
Tipula subandina Philippi.
Tipula apterogyne Philippi.
Tipula rufostigmosa Macquart.
Tipula variinervis Bigot. (= *picti-pennis* Walker.)

Pachyrhina macrosterna, sp. n.

Thoracic stripes not complete, represented, when at all evident, only by spots at the margins of the præscutum; dorsal apical appendage of the ♂ genitalia prolonged, stylet-like.

♂ Length, 10.3—10.8 mm.; wing, 11.4—11.8 mm.
Middle leg, femur, 8 mm.; tibia, 8.9 mm.
♀ Length, 12.8 mm.; wing, 13.2 mm.
Fore leg, femur, 8.9 mm.; tibia, 10.7 mm.
Hind leg, femur, 9.3 mm.; tibia, 10.6 mm.

♂ Head: Anterior prolongation of the front brownish-yellow, clearer yellow beneath and on the sides; palpi brownish; antennæ, basal segments orange-yellow; 3d segment brownish-yellow; remaining segments dark brown basally, gradually fading into the yellowish-brown apical portion of the segment; terminal three or four segments uniform brown. Front, vertex and occiput yellow, more brownish in the middle of the vertex, very broadly shiny, this mark not clearly delimited but embracing most of the space between the eyes.

Thorax: Pronotum dull pale yellow; mesonotum, præscutum shiny, brownish-yellow, without clearly defined stripes; pleuræ dull with a pale yellowish bloom. Halteres, stem pale, knob brownish. Legs: coxæ and trochanters yellow; femora brownish-yellow, the extreme tip dark brown; tibiæ yellowish-brown, extreme tip indistinctly darker; tarsi brown. Wings hyaline or nearly so, cells *C* and *Sc* yellow, stigma pale. Venation: Rs short, a little longer than R_2; petiole of cell M_1 long, as long as the basal deflection of R_{4+5}.

Abdomen: Tergum, segments shiny, segment 1 yellow, narrowly margined with brown behind; segment 2, yellow, brown on the caudal half, a large rounded brown spot on the lateral margin; segments 3 and 4 mostly brown, more yellow basally, with a gradually smaller brown spot on the lateral margin of each of the sclerites; segments 5 and 6, brighter, more yellowish; segment 7 dark, almost black, margined with pale; hypopygium orange-yellow; sternum, yellowish. Hypopygium: 7th tergite, short, shorter than the tergites immediately preceding; 8th

tergite distinct, about as wide as the 7th, its caudal margin straight, its lateral corners evenly rounded; 7th sternite rather broad, broader then the sixth sternite; 8th sternite very large, longer than the three preceding segments combined and projecting caudad beyond the remaining appendages; its ventral face is evenly rounded, broad at the base, narrowing apically, at its tip turned abruptly dorsad and ending in two blunt teeth, these teeth bifid with the caudal denticulum rather the longer. Above the origin of the 8th sternite arises the 9th sternite: broad basally, rapidly narrowed toward the tip into a chitinous, spoon-like appendage, convex on its outer face, concave on its inner. 9th tergite with the caudal margin rather deeply incised medially, the adjacent lobes brown, chitinized, and bent ventrad at the tip. Two distinct sets of apical appendages arising from the genital chamber, which may, or may not, be connected with one another nearer their bases; first, a pair of dorsal-lieing appendages which are bifid with the ventral tooth greatly prolonged, stylet-like (see Fig. k_1). Beneath these are two large complex appendages (see Fig. k) which may be described as being three-branched, the ventral branch is strongly chitinized and expanded, six-toothed, of which the most dorsad is the largest; the dorso proximal branch (a) is flattened, its margin chitinized and somewhat reflexed, bearing a spine near its outer edge at the tip; the dorso-distal branch (b) is slender, more fleshy and bears scattered hairs at its apex. Between the ventral organs, just ventrad of the dorsal pair is a large, pale fleshy organ.

♀ Antennæ mostly yellowish excepting the apical segments which are brown. On the cephalic margin of the mesonotal præscutum is a dark brown spot on either side of the usual broad median stripe which is here not indicated; a large brown spot on the sides of the sclerite about at the anterior end of the usual lateral stripe. Ovipositior (see Fig. r) with the valves very short, blunt, evenly rounded on their lateral margin.

A paratype male shows the fore portion of a lateral stripe on the præscutum.

Holotype, ♂, Antigua, Guatemala. Sept., 1902 (Dr. G. Eisen).

Allotype, ♀, with the type.

Paratype, ♂, Aguna, Guatemala. (Dr. G. Eisen). (Received at U. S. National Museum, Jan. 6, 1903).

Types in U. S. Nat. Mus. Coll. (No. 15,072).

Paratype in author's collection.

Pachyrhina macrosterna, and the following species, *trinidadensis*, are closest allied to *circumscripta* Lw, *ferruginea* Fabr. and *elegantula* Will., in the respect that the thoracic stripes are not jet-black. The other nine Neotropical species are all black-striped species. These two species form a distinct group, (*macrosterna* group), differing from the species named above in their petiolate cell M_1 and powerful hypopygium. The petiolate cell M_1 suggests *collaris* Say of the Northeastern United States, a very different insect.

Pachyrhina trinidadensis, sp. n.

Similar to *macrosterna* but antennæ darker; three distinct brown thoracic stripes; dorsal apical appendage of the ♂ genitalia chisel-shaped, sub-truncated at its apex.

♂ Length, 11 mm.; wing, 10.8 mm.; antennæ, about 4.5 mm.
♀ Length, 12—13.2 mm.; wing, 12.2—12.8 mm.
Fore leg, femur, 7.7—7.8 mm.; tibia, 9.4—9.8 mm.
Middle leg, femur, 8.5 mm.; tibia, 8.8 mm.
Hind leg, femur, 9 mm.; tibia, 9.9 mm.

♂ Head: Anterior prolongation of the front and the palpi brown. Antennæ, two basal segments light orange-yellow; 3d segment, basal half brown, apical half yellow, remaining segments brown, extreme apice of each segment yellowish, this yellow color becoming obsolete on the outer segments. Front, vertex and occiput brown, the center of the vertex broadly shiny and brighter brown.

Thorax: Pronotum very pale yellowish-white, not shining; mesonotum shiny, præscutum light yellow with three dark brown uniform stripes; the middle stripe is broadest on the anterior portion of the sclerite, rather narrower behind; the lateral stripes bent strongly ventrad at the pseudosuture (*humeral pit* or *dorso-pleural* suture of Osten Sacken); scutum yellowish with two dark brown spots on each lobe; scutellum lighter brown; post notum brownish-yellow, thinly pale pollinose; pleuræ pale with a sparse greyish pollen. Halteres pale, gradually darkening to the brown knob. Legs: coxæ and trochanters light clear yellow; femora brown, the tip narrowly dark brown; tibia and tarsi brownish. Wings: color and venation almost exactly as in *macrosterna* of Central America (see Fig. h.).

Abdomen: Tergum brownish, the lateral margins of the sclerites clearer yellow, not darker on segments 2 to 4; segment 7 with the basal half dark brown; remainder of tergum and the sternum, brownish-yellow. Hypopygium (see Fig. j); 7th and 8th tergites and 7th sternite as in *macrosterna;* 8th sternite with the caudal denticula (d) about equal to the cephalic one; 9th sternite (9s) viewed from the side with an obtuse notch on the ventral face. Apical appendages: The dorsal-lying appendage (c) projects straight backward, enlarged at the apex, chisel-shaped, the outer angles equal, the caudal margin gently concave (see Fig. j_2); the appendages lie in a vertical plane and side by side, separated from one another by a distance about equal to the width of one. The second, or ventral, appendage (see Fig. j_1) the ventral branch of *macrosterna* is, apparently, lacking; the dorso-proximal branch is chitinized and bears a sharp spine on the caudal margin, this spine being bent outward (a); on the sides of the appendage is a large prominent spine which projects ventrad and outward (x) toward the appendage of the 9th sternite which it almost touches; at its base, a small hair-bearing projection; the margin of the appendage below the large spine curves distad, is chitinized on the extreme edge and bears long hairs; I cannot perceive any structure corresponding to the dorso-distal branch of *macrosterna;* a large pale organ lying between these ventral appendages and just beneath the paired dorsal appendages.

♀ Quite similar to the ♂, the shiny spot on the vertex brown; the median præscutal stripe very broad, in front almost touching the anterior end of the lateral stripe; a brown spot on the mesopleuræ about midway between the coxa and the pseudo suture; ovipositor about as in *macrosterna;* upper valves tipped with black; lower valves, viewed from the side, broad at the base, the ventral margin concave, obtuse at the tip; viewed from beneath, flattened, bearing scanty long hairs on the outer face, the tips touching.

Holotype, ♂, Port of Spain, Trinidad, Sept. 25, 1901, (H. Carciniola).

Allotype, ♀, with the type.

Paratype 1, ♀, with the type.

Paratype 2, ♀, Trinidad, West Indies, (Aug. Busck).

Types in U. S. Nat. Mus. Coll. (No. 15,073) except paratype No. 2, in author's collection.

Tipula armatipennis, sp. n.

Color light yellow; wing unmarked; a distinct spur on the costa near the stigma in the ♂.

♂ Length, about 13.5 mm.; wing, 14.4 mm.; antennæ, about 6 mm.

♀ Length, about 15.5 mm.; wing, 14.8 mm.

♂ Head: Anterior prolongation of the front yellowish-brown; mouth-parts similar. Palpi light yellow, more brown apically, the last segment about as long as the basal three combined. Antennæ, scapal segments yellow, the first cylindrical, the second very short, broader than long, with a thick brush of stout black hairs on its inner face; flagellum, segments (except the first) more or less enlarged at the base and slightly constricted in the middle, the swollen base with a few long black hairs, the segment densely clothed with a pale pubescence; segments 3—4, yellowish, except at the black knot, this color passing into a uniform dark brown on the apical segments. Front, vertex and occiput pale brownish-yellow with a sparse greyish bloom.

Thorax: Pronotum light yellow; mesonotum, præscutum, light yellow without distinct stripes; scutum orange with indistinct darker spots; scutellum depressed on the sides, swollen medially, brownish-yellow; post-notum dull yellow. Pleuræ yellow, with a sparse greyish bloom. Halteres uniform yellow, knob brownish. Legs broken. Wings: subhyaline; stigma large, oval, brown; cells *C* and *Sc* tinged with yellow; the apices of cells R_2 and R_3 tinged with brown; veins brown. On the costal margin of the wing, above the middle of the stigma, is a distinct spine or spur. Venation (see Fig. g); Sc long ending at the base of the stigma; Rs short, less than twice as long as the deflection of R_{4+5}; R_{2+3} short, forming the caudal margin of the stigma; R_2 short, subperpendicular, basally forming the distal side of the stigma; cell 1st M_2 small, pentagonal.

Abdomen: Tergum, segment one dark brown, indistinctly black medially; remaining segments reddish-brown, darker basally. Hypopygium swollen. Sternum brownish-yellow; 7th segment black both on the sternite and pleurite. Hypopygium: (see Fig. o); 7th sternite, caudal margin almost straight; lateral margin impressed, wavy; 7th tergite, caudal margin straight; 8th sternite, (8s), broad at the base, narrowed apically, running caudad slightly beyond the remaining appendages; the base is shiny, the tip short-cylindrical, dull, opaque; the tip bent strongly dorsad and deeply notched at its base; the dorsal surface of the eighth sternite is deeply concave, hollowed-out; at the notch, on the dorsal margin, is a small flattened lobe (c), directed upward, its caudal margin narrowly chitinized, the tip densely fringed with long pale hairs. 8th tergite very narrow (8t.) represented only by a narrow strip, concave on its caudal margin and consequently even more reduced on the middle line. 9th sternite (9s) broad basally, the dorsal margin with a broad, obtuse notch; a blunt tooth on its caudal margin, ventrally the margin is rolled inward, forming a broad, obtuse notch on the margin; the inward-projecting arm is chitinized, its inner margin thinned and bearing a dense fringe of long pale hairs which overlap those of the opposite side and form a dense mat under the apical appendage and over the 8th sternite. 9th tergite (9t) moderate, medially with a deep notch on the caudal margin; the adjacent lobes being sharply pointed, bent ventrad at their tips, sub-chitinized and with hairs and minute denticulæ along the inner face; the latero-caudal margin of this sclerite is thinner and bears a fringe of sub-equal, pale hairs. The apical appendage (a) is dorsal, flattened, bearing two teeth, the most dorsal and innermost project inward, very sharp, slender, chitinized, almost touching its fellow on the middle line; the ventral tooth (a) longer, directed more caudad; the outer margin of this appendage clothed with long hairs; below the apical appendage, a flattened median organ (b), its caudal margin vertical, evenly convex, narrowly chitinized, and fringed with fine hairs. Below the 9th tergite and between its arms, in the specimen at hand, the penis (p.) projects; it is extremely elongated and if straightened would be considerably longer than one-half of the abdomen.

♀ Like the ♂ but the antennæ short, the flagellar segments cylindrical, subequal, not swollen basally, basal half of each segment brown, apex yellow. Wing without a spur, but venation as in the ♂. Ovipositor: (v, v_1) 8th tergite, concave on the caudal margin; 9th tergite very narrow and not as wide as the rest of the abdomen, its caudal margin concave. Base of the ovipositor short, almost as broad as long, the valves short, their tips chitinized and sub-spatulate, viewed from the side (v_1), the valve is wider than its base narrowed near the tip, the tip again expanded; lower valve shorter than the upper, directed caudad and upward, the valves extremely high, blunt at the apex. The 9th sternite is very long.

Holotype, ♂, Chapada, Matto Grosso, Brazil (H. H. Smith, coll.)

Allotype. ♀, with the type.

Types in Am. Mus. of Nat. Hist., New York.

I know of no species of *Tipula* that even approaches this remarkable fly. No form in the American fauna has a spur on the wing.

Tipula guato, sp. n.

Color light yellow; flagellum of antennæ bi-colored; wing subhyaline.

♂ Length, about 12 mm.; wing, 11.5 mm.

Fore leg, femur, 7.6 mm.; tibia, 9 mm.

Head: Anterior prolongation of the front rather short; nasus not distinct, but with a long brush of hairs in its normal position; dull yellow, brightest on the sides. Palpi, light yellow, short. Antennæ, basal segments yellow, second segment with a brush of hairs on the inner face; flagellum, segments swollen on the ends, narrowed medially; the basal knot blackish, and with a few prominent hairs; the entire segment clothed with dense pale hairs; basal segments of flagellum with apices yellow, this color gradually passing into the dark brown of the terminal segments. Front, vertex and occiput dull brownish-yellow.

Thorax: Mesonotum, præscutum dull yellow without apparent stripes; scutum, scutellum and post-notum similar but more or less suffused with brown. Pleuræ dull yellow, sparsely greyish pollinose. Halteres, stem yellow, knob brown. Legs: coxæ and trochanters light yellow gradually passing into the brown of the tarsi (only fore legs remain). Wings: Subhyaline; stigma oval, pale brown; cell C and apices of cells R_2 and R_3 tinged with yellow; veins brown, Sc more yellowish. Venation: (see Fig. e); Sc long ending far beyond Rs; Rs short, about as long as M_{1+2} between cross-veins *r-m* and *m;* R_{2+3} in a line with R_3; R_2 oblique; cell 1st M_2 rather elongated; petiole of cell M_1 short; cross-vein *m-cu* distinct.

Abdomen: Tergum light brown, almost uniform; 7th and 8th black; hypopygium yellow; sternites light brown; 7th and base of 8th black. Hypopygium: (see Fig. p); 7th sternite broad, its caudal margin almost straight; 7th tergite almost convex; 8th sternite (8s) broad at the base with a very obtuse tooth on its dorsal margin; produced behind into a blunt point which is broadly and obtusely notched at the tip; 8th tergite (8t.) moderately broad, about one-third as wide as the 7th, rather widened at the ends, but the caudal margin almost straight; 9th sternite (9s) subquadrate, large, its dorsal margin straight; its caudal margin truncated; ventral margin with an obtuse ventral-projecting tooth; the inner margin is bent inward and has a dorsally-directed tooth; this inward projection of the 9th sternite fills a considerable portion of the genital chamber between the 9th sternites and just dorsad of the 8th sternite. Along the median line it is deeply notched, and the whole external face is densely covered with delicate, silvery-white, appressed hairs. 9th tergite (9t.) rather short with an obtuse median notch, the adjacent teeth broad, obtuse, projecting downward, densely covered with short, stout hairs, the extreme base of each tooth,

on either side of the median notch, produced ventrad into a small spine. The apical appendage is dorsal; the caudal margin is rather straight, the outer upper angle produced dorsad into a chitinized tooth which is slightly bifid at its apex, the chitin continuing down the anterior side of the appendage in a narrow line; the inner margin of the appendage straight, with scanty long hairs which cross over the median space and meet those of the other side. Between the chitinized teeth, on the median line, is a pale, horse-shoe shaped organ which probably surrounds the penis which is not exserted in my single specimen.

Holotype, ♂, Chapada, Matto Grosso, Brazil (H. H. Smith, coll.)

Type in Am. Mus. of Nat. Hist., New York.

The specific name is derived from a native tribe. "The central parts of Matto Grosso at the foot of the plateaux are occupied by the Guatos, some of whom are still in the wild state." Reclus, Universal Geography, Vol. XIX, p. 258. The latest and best account of this tribe is by Dr. Max Schmidt, "Reisen in Matto Grosso in Jahre 1910."*

Tipula smithi, sp. n.

Light brownish-yellow; costal margin of wings brown.

♀ Length, about 13 mm.; wing, 12.8 mm.

Head: Anterior prolongation of the front, short, light greyish-brown; palpi light brown. Antennæ, first eight segments clear light yellow, the apical segments gradually suffused with brownish. Front, vertex and occiput greyish-brown. Thorax: Mesonotum, præscutum light brown without apparent stripes; scutum similarly brown; scutellum and post-notum light yellow. Pleuræ yellow with a pearly-grey bloom. Halteres light brown. Legs: coxæ yellowish with a grey bloom; trochanter light yellow; rest of legs gone. Wings: Nearly hyaline; stigma rounded, dark brown; the costal margin suffused with brown, the brown pattern including cells C, Sc, the cephalic half of R (where it becomes paler, more yellowish); basal third of cell 1st R_1; all of cell 2d R_1; cell R_2; cell R_3, except a hyaline spot in the proximal end and another over the middle of vein R_{4+5}; brown clouds at origin and tip of cell R_5; along basal deflection of Cu_1; along cross-vein *m;* at fork of M_{1+2}, and at the ends of the longitudinal veins. Venation: (see Fig. f); cross-vein *r* about as long as that portion of R_2 below it; R_3 short, about twice as long as R_2; basal deflection of R_{4+5} long, almost obliterating cross-vein *r-m;* petiole of cell M_1 almost as long as that cell; fusion of M_3 and Cu_1 extensive, not quite as long as cross-vein *m*.

Abdomen: Tergites brownish-yellow; sternites clearer yellow; second segment very long, as long as 3 and 4 combined; 9th tergite with caudal margins concave (see Figs. w, w_1), the caudo-lateral angles

*Zeitschrift fur ethnologie; vol. 44, pt. 1; p. 130–174; especially, p. 131–137; (1912).

produced into short obtuse points; valves of the ovipositor very short, divergent, the basal piece longer than the tips; lower valves (see Fig. w_1, *l*); very short, broad at the base, truncated at the tip.

Holotype, ♀, Chapada, Matto Grosso, Brazil (H. H. Smith). Type in Am. Mus. of Nat. History.

This handsome species is named in honor of the pioneer collector, Mr. Herbert H. Smith.

Tipula inca, sp. n.

Grey; wings indistinctly spotted; legs short, stout.

♂ Length, 11.5 mm.; wing, 13.4 mm.; antennæ, about 8.5 mm. Fore leg, 21 mm.; middle leg, fem. 6.8 mm.; tibia, 5.6 mm.; tarsus, 6.5 mm.; hind leg, fem. 7.8 mm.; tibia, 8.3 mm.; tarsus, 7.9 mm.

Head: Anterior prolongation of the front white, very pale, with numerous brown hairs on the distal half above; nasus not prominent; palpi brown, first segment light brown, shorter than the second, slender; second, paler brown basally, greatly thickened distally; 3d segment again slender except at the base; 4th very irregular, brown, except at the extreme base where it is yellowish; mouth parts dark brown. Antennæ, 1st segment short, much thickened distally; 2nd short; 3d one and one-half the length of the 1st; remainder very flexible, elongated, at the basis armed with four or five strong, black hairs, the whole surface covered with a fine pubescence. Basal segment light yellow, somewhat darker at tip; 2d brownish-yellow; 3d silvery greyish-brown; remainder light brown. Front pale silvery-white; vertex and occiput grey with a dark brown median line beginning between the antennæ, running caudad. Head closely applied to the prothorax.

Thorax: Pronotum silvery-grey, medially with a broad brown stripe. Mesonotum, grey with a very narrow dark brown median line, broadest before, gradually narrowing toward the suture, lateral margins of præscutum dark brown except extreme edge; between this brown and the median stripe, an indistinct pale brown stripe on the caudal half, ending at the suture; scutum, grey medially, yellowish on the sides; scutellum grey, a large flattened brown area on the sides above the wing-roots; post-notum grey, brownish medially and on the sides. Pleuræ and sterna silvery-whitish, tinged with grey. Halteres long, yellowish. Legs short, stout, femora somewhat incrassated at tip, pale yellowish-brown, tip rather darker; tibiæ and tarsi brown.

Wings: Hyaline, cells *C* and *Sc* tinged with yellow; stigmal area pale greyish; a vague grey suffusion around cross-vein *m* and on outer deflection of M_3; caudal third of cell M along vein *Cu*, grey, this also continuing onto Cu_1 and Cu_2 as a very narrow seam; cells of wing in vicinity of anterior (cephalic) half of the cord, greyish; two pale clouds in base of cell *Cu;* margin of anal angle grey. Venation as in Fig. c.

Abdomen: Pale brownish-yellow; middle of 1st tergite brown, which color continues back over the succeeding three segments as a narrow line; sternites brownish-yellow, the sclerites at pleural margin

deeply incurved, dusky, giving an indistinct lateral stripe. Hypopygium: (Fig. l); 8th tergite, (8t), moderately long, its caudal margin almost straight, its caudal margin very feebly concave medially; 8th sternite, (8s) short and high, only about two-thirds as long as the 7th sternite, but very high at its base; viewed from the side, triangular, its tip turned dorsad and clothed with long hairs; 9th tergite (9t) broad, viewed from above, much broader than the 8th tergite, swollen basally, the caudal margin broadly concave, in the middle, feebly convex and here with a minute square median notch (Fig. l_1); viewed from the side (l) the 9th tergite is truncated at its tip and broadly notched, its ventral-caudal margin gently concave; the suture separating the 9th tergite and sternite not complete. 9th sternite, viewed from the side (l, 9s), its dorsal margin about straight attached to the tergite on its cephalic or anterior portion; its caudal margin about straight; along its caudal face, an elongate body (y), convex outerly; its ventral margin applied to the caudal prolongation of the ventral face of the 9th sternite; at its dorsal end it is produced into a fleshy, feebly chitinized body (a), densely covered with pale hairs which are longest apically; viewed from the side, it is slender with a bump on the middle on its outer face. Proximad of this organ, in the notch of the ventral paired organ on the 9th sternite, is an elongate, slender organ (b) directed dorsad; its base is slightly enlarged, its stem very slender with long pale hairs on its inner face, these directed toward the median line; the tips of these organs are greatly produced on the proximal side, here sub-chitinous, the tip chitinized, black. In a position of rest, the inner edge of this organ is closely applied to its fellow at the median line; the caudal face of this broad expansion is provided with three or four transverse ridges and its ventral margin is fringed with long pale hairs; viewed from above this organ resembles Fig. l_1; the outer tooth most chitinized, black; the inner, less chitinized except on its outer margin; recurved at the tip and directed cephalo-ventrad. Viewed from beneath, the 9th sternite has the caudal margin concave, a pair of elongate median organs directed caudad, these organs (c) slender, swollen at their tips, the tips closely applied, densely clothed with appressed, pale hairs.

Holotype, ♂, Callanga, Peru. (Rec'v'd from Staudinger-Bang-Haas).

Type in author's collection.

The specific name is derived from the great Indian nation formerly inhabiting Peru.

Closest related, apparently, to *glaphyroptera* Phil.; *subandina* Phil., and *apterogyne* Phil., of Chile in the greyish color. I have before me specimens of all of the above, excepting *glaphyroptera*, which differs widely from *inca* in *antennal* and *wing* characters.

Tipula aymara, sp. n.

Orange; costal margin of the wings dark; cross-veins not seamed with brown; radial cells light brown.

Length, ♂, 15 mm.; wing, 17 mm.; antennæ, about 7.6 mm.
Length, ♀, 13.8 mm.; wing, 14.6 mm.
Hind leg, ♂; fem. 10.4; tibia, 13.3; tarsus about 25.5 mm.
Hind leg, ♀; fem., 8; tibia, 9.6 mm.

♂ Head: Anterior prolongation of front short, light brown; palpi, segment one, shorter than two, brown; 3d about equal to 2d, dark brown at base; pale, yellowish, at tip; 4th, very long, lash-like, twice as long as the rest of the palpus together, yellow. Antennæ, segments 1 to 3 orange-yellow; remainder brown, with a fine white pubescence; three or four bristles at the base of each segment and a single one near the middle. Front and vertex brownish-orange; occiput brown; the vertex very thickly beset with numerous long hairs; this including the whole region bounding the eyes, both above and beneath.

Thorax: Collare orange. Pronotum orange-yellow. Mesonotum, præscutum and scutum orange without distinct markings; scutellum and postnotum yellow. Pleuræ and sternites clear yellowish-orange. Halteres yellow, knob darker. Legs: coxæ, trochanters and extreme base of femora light yellow; rest of femora, tibiæ and tarsi brown; all of the coxæ thickly beset with long yellow hairs. Wings (see Fig. b) with a pale brownish-grey tinge; cells C, Sc, most of 2d R_1 light brown; the distal half of cell 1st R_1 dark brown, forming the stigma; no brown seams on the cross-veins or deflections. Radial cells, indistinctly suffused with very light brown distally; cross-vein ***r-m*** slightly margined with brown.

Abdomen: Tergum, 1st segment, yellow; 2d brown; 3d, 4th, dark brown; 5th, 6th, lighter brown; 7th, 8th, black; the 1st to 5th tergites are very deep, so that viewed from the side, they conceal the sternites; the 6th sternite shows caudally, the 7th is one-third as high as the 7th tergite, the 8th sternite subequal to the 8th tergite. Sternum, segments one to five, invisible, 6, orange, 7—9, black. Hypopygium (Fig. m). 7th sternite almost straight along the caudal margin; 7th tergite, broad, its caudal margin almost straight, very feebly concave. 8th sternite (from beneath), broad, the caudal margin with an obtuse median notch, the adjacent lobes broadly rounded and clothed with a dense brush of long yellow hairs; (from the side) (8s) with the dorsal margin gently sloping; the tip truncated. 8th tergite, (8t) reduced to a mere strip, its caudal margin rather strongly concave so that the median portion is scarcely visible. 9th sternite (9s) appearing as the half of an oval, the outer face sub-shiny, convex, a small group of long hairs on its dorsal angle; the dorsal margin strongly bent entad, the proximal margin straight, almost in a line with the notch on the 8th sternite, the two together making a very deep V-shaped niche; the proximal-ventral side is strongly produced into a rectangular arm, projecting entad, its tip strongly truncated, almost touching its fellow of the opposite side. Looking into the end of the genital chamber (see Fig. m_1) there appears

to be an appendage to the 9th sternite, a semi-lunar, feebly-chitinized piece (z) flattened and the tip slightly expanded, bearing a fringe of long pale hairs on its proximal margin, these projecting inward; at the tip, the hairs become very stout, bristle-like, black, and the organ ends in two or three chitinized teeth which are directed dorsad and slightly outward; underneath the tip of this appendage is a rounded, chitinized organ (b) produced caudad into a long spine; it is black, very conspicuous, occupying the niche between the 9th sternite and tergite, its rounded face directed outward through the niche. 9th tergite (9t), rectangular, its sides square, its caudal angles almost right; on the caudal margin, a broad median lobe, very obtuse and enlarged at the apex, black and very densely clothed with short hairs; the very conspicuous lobe is concave at its tip, projects caudad, the tip very slightly ventrad. Apical appendages, from the genital chamber: dorsal lying, on either side of the median line, an elongate-triangular organ (w) broad at the base, directed dorsad and slightly caudad, the tips touching, the cephalic margin densely clothed with pale hairs; the opening between them (looking into the genital chamber) is elongate-oval and in it is a perforate membrane through which the penis is probably exserted. The ventral lying appendage (a) viewed from the side, roughly triangular, one angle directed caudad, another ventrad; caudal face gently concave; the whole organ densely clothed with long pale hairs, longest on the dorsal margin; viewed from above, it is seen that the dorsal edge is thickened, narrowing to the sharp ventral margin (Fig. m_1 *a*).

♀ Similar to the ♂, but antennæ much shorter, segments 1—5, yellow; abdomen, segments 1—2 yellow with lateral margin of tergum black; segments 2—6, black, yellowish in the middle of the lateral margin of tergites; 7—8 black; 9 yellow. Sternites 4—6 distended with eggs; shoved out of the tergal covering, black with a yellow wash. Genitalia: 9th tergite about as long as the 8th, its caudal margin broadly impressed medially; appendage to the 9th tergite broad basally, sub-shining, ending in a blunt lobe, its tip rounded, deeply notched, the lobes fringed on the inner edge with short pale hairs. From beneath, the 9th sternite is very long, its caudal margin deeply notched, the valves projecting from the middle of this notch, the lateral margins lobed and bent inward; 9th sternite very long. (See Figs. s, s_1).

Holotype, ♂, San Antonio, Bolivia (Recv'd from Staudinger-Bang-Haas).

Allotype, ♀, with the type.

Types in author's collection.

The specific name is that of a native tribe. "The Aymaras, who constitute the chief ethnical element of the Bolivian nation, are in almost exclusive possession of the plateau regions and their domain also encroaches northward on Peruvian territory. The true center of the race lies in the islands, headlands and shores of Lake Titicaca." Reclus, Universal Geography, Vol. XVIII, p. 368.

This species and the next, *parishi*, are members of the *longitarsis* Mcq't group, possessing elongated antennæ in the ♂; costal margin of wings darkened, with the remainder of the wings subhyaline, no white longitudinal stripe in under R, (*oleracea* group, as *virgo* O. S., *virgulata* Will.); ♀ ovipositor with remarkably shortened valves; color of the species yellow or orange with one or more subterminal abdominal segments black. Here belongs *longitarsis* Macquart, *tabida* End. (Peru) and *appendens* End. (which is certainly not a *Macromastix* as its describer believed) from Ecuador, as well as the two new species. *T. aymara* differs from *appendens* in being much larger; veins not seamed with brownish and distal ends of the radial cells uniformly suffused with darker. From *tabida*, it differs in wing coloration; not only the penultimate abdominal segment is black, but the antepenultimate as well (and most of the remaining tergites in the ♀). T. *longitarsis* has a large quadrangular brown spot in cell M_1 near the cubital vein.

Tipula parishi, sp. n.

Small; orange; costal margin of wings dark; veins in distal portion of the wing seamed with brown.

♂ Length, 11.9 mm.; wing, 11.8 mm.; antennæ, about 8 mm. Middle leg, femur, 8.6 mm.; tibia, 8.8 mm.; tarsus, about 23 mm.

Head: Anterior prolongation of the front brown; palpi brown. Antennæ, two basal segments yellow; 3d dull yellow; remainder, base black, tip dull yellow; on the 6th and following segments the yellow color is very much reduced. Antennal segments covered with a dense pale pubescence and a few long black hairs; the segments are all elongate-cylindrical, the base only a trifle more enlarged than the stem. Front, vertex and occiput dull brown; eyes metallic.

Thorax: Dull brownish-yellow without distinct præscutal stripes; the scutum, scutellum and postnotum even darker brown. Pleuræ yellowish-brown, lighter ventrally, passing into the clear light yellow of the coxæ. Halteres brown, stem a little paler. Legs: coxæ, trochanters and femora yellow, the femora gradually becoming brownish-yellow apically; tibiæ and tarsi brown. Wings: Subhyaline, cells C, Sc, extreme cephalic margin of R, base and tip of 1st R_1, 2d R_1 and tips of R_2, R_3 and R_5 brown, the stigmal area rather the darker. Brown seams along the cord, including a large seam on the basal deflection of Cu_1 near the fork of Cu; cross-vein *m* seamed with brown. Venation: Rs short, arcuated, about as long as the basal deflection of Cu_1; R_{2+3} short, less than Rs, about equal to R_2; cross-vein *r-m* not reduced, about one-half as long as the deflection of R_{4+5}; fusion of Cu_1 and M_3 about as long as *r-m*.

Abdomen: Tergum, segments 1—3, yellow, the lateral margins of the sclerites broadly brown; on the 4th and succeedings tergites, the brown lateral margins of the sclerites are paler but suffuse the whole segment; 7th and 8th sclerites black; 9th yellow. Sternites, 7th black, 8th black basally; remainder of sternum yellow. Hypopygium: (see Fig. n). 7th sternite and tergite about as in *aymara;* 8th sternite rather short, its length scarcely more than the 7th, its caudal margin quite straight, as in the 7th. 8th tergite, broad on the sides, the caudal margin quite deeply concave, reducing the median portion very considerably. 9th sternite (see Fig. n, 9s); cylindrical, rather elongated; viewed from beneath (n_1) the whole caudal margin is squarely notched, this notch toothed and notched again. Viewed from the side, the dorsal margin is straight basally, then straight apically, the angle being about 150°; near its tip, produced into a complex appendage (Fig. n, *v*) its cephalic arm conspicuously chitinized, black, its caudal margin conspicuously fringed with hair. 9th tergite (see n, 9t); caudal angles evenly rounded; caudal margin gently concave with a distinct blunt median tooth, which, on the ventral surface of the sclerite, is seen to be bent ventrad and continued cephalad, as an oval organ densely covered with minute chitinized teeth on the ventral surface, these denticules more numerous on the margins. Apical appendages; dorsal-lying, viewed laterally, (a), elongate, slender, projecting straight backward, the tips expanded, rounded; viewed from above, it is seen that this organ is median, but deeply bifid at its tip (n_2), giving the appearance of being a paired organ; the tips are divergent, enlarged apically into a rounded knob. Ventral-lying appendage, viewed laterally (b) subequal to the dorsal appendages in length, project caudad and slightly dorsad, the tips acutely pointed; from above, this organ is broad, slightly notched at the tip, and its dorsal surface appears to be concave.

Holotype, ♂, Igarapé-assú, Para, Brazil, Jan. 26, 1912, (H. S. Parish, coll.)

Type in Cornell University Collections.

I take pleasure in dedicating this interesting species to the well-known South American traveller and collector, Mr. H. S. Parish.

This little species is allied to *appendens* End. but differs considerably in coloration; the basal deflection of Cu_1 is distinctly seamed with brown. This insect bears a certain resemblance to *aymara* but is strikingly distinct in wing coloration and hypopygial characters. The flagellar segments in *aymara* are distinctly enlarged at the base; in *parishi* not at all swollen basally, the segments being uniformly cylindrical.

Tipula atacama, sp. n.

Small; yellow and brown; wings reddish-brown with hyaline spots; femora dark with a light subapical ring.

♀ Length, about 12 mm.; wing, 14.2 mm.
Fore leg, femur, 6.8 mm.; tibia, 7.6 mm.; tarsus, about 12.5 mm.

Head: Anterior prolongation of the front and palpi light yellowish-brown, the latter darker toward the tip. Antennæ, segments 1—3, orange-yellow, remainder black. Front with a distinct protuberance just behind the antennæ; front, vertex and occiput pale yellow.

Thorax: Pronotum light yellow, a brown transverse mark in front; a semi-lunar brown spot on either side behind. Mesonotum, præscutum dark brown behind, a broad dark liver-brown median stripe of this color beginning near the cephalic margin of the sclerite, broadest in front, narrowing behind, reaching the suture; the caudal half of the sclerite is thinly grey pruinose; cephalic half, on either side and in front, of the median stripe, bright orange; scutum dark brown, thickly grey pollinose; scutellum and postnotum dull yellow, brown on the sides. Pleuræ, brown, more yellowish ventrally; sternum yellow. Halteres yellow, knob slightly darker. Legs (fore only remain): coxæ and trochanter yellow; femur, light yellowish-brown, a dark brownish-black ring at the tip with a light yellow subapical ring; tibia and tarsus brown. Wings: suffused with pale reddish-brown, adorned with hyaline spots arranged about as follows: (1) the clearest fill most of cell 1st M_2 and extends down into the base of cell M_3, the outer deflection of M_3 being whitened; (2) in cell $1R_1$ above the fork of Rs; (3) In cell C above the tip of *Sc*. Less clear spots are in the center of cell R and, nearer the tip; a double spot near base of cells R_3 and R_5; one at base of M and cu; pale centers to cells M, Cu and 1st A. Venation as in Fig. d.

Abdomen: Tergum, light yellow, segments 3—8 slightly darker brown caudad; extreme ventral margin of tergites dark brownish-black. 8th tergite narrow, especially medially, due to the concave caudal margin. 9th tergite (see Fig. u) narrow, moderately long; base of the ovipositor cylindrical; the valves (u) broad at the base, rapidly narrowing to the slender, sub-spatulate tips. 9th sternite broad basally, conical, the valves (e) flattened, blade like, shorter than the upper valves.

Holotype, ♀, San Antonio, Bolivia, (Received from Staudinger-Bang-Haas).

Type in author's collection.

The specific name is that of a native tribe of Indians dwelling west of the Andes and south of the region inhabited by the Aymaras.

It may be allied to *decorata* Phil. and *frauenfeldi* Schin. (Chilian species) in the tuberculate front, but is little related in other respects. In wing-coloration, *atacama* shows some resemblance to *flavipennis* Phil. (Chile) but is only about half as large and shows conspicuous colorational differences.

Tipula maya, sp. n.

Large; thorax brownish-yellow, striped; wings brown; cross-vein *r* before the fork of R_{2+3}.

♀ Length, 28 mm.; wing, 27.6 mm.
Fore leg, femur, 14 mm.; tibia, 16.8 mm.
Middle leg, femur, 15.9 mm.; tibia, 15.4 mm.
Hind leg, femur, 16.2 mm.; tibia, 18.7 mm.; tarsus, seg. 1, 18 mm.; seg. 2, 4 mm.; seg. 3—5, 3.5 mm.

Head: Anterior prolongation of the front, and the palpi, dark brownish-black. Antennæ, basal segments brown, flagellum broken. Front, vertex and occiput dark brown, occiput paler.

Thorax: Pronotum dull yellow, the scutum and caudal margin of the scutellum brown. Mesonotum, præscutum dull brownish-yellow, brighter, yellow, along the lateral margin of the sclerite; extreme cephalic margin of the sclerite dark brown, continued backward as a narrow median stripe broadening out in the middle but soon becoming faint and almost obsolete; the lateral stripe begins at the front angle, continues caudad; at about one-third the length of the sclerite it forks, the inner branch continuing directly caudad in a line with the main stem and running to the transverse suture; it is palest medially, the edges brown. The outer branch bends toward the edge of the sclerite and continues back to the side of the scutum; scutum brown, dark brown on the sides and on the caudal margin; scutellum dark brown medially, the sides light brown, a narrow yellow stripe on the cephalic margin; postnotum dark brown with a pale narrow, median vitta. Pleuræ very pale brown except the dorsal edge which is yellow; a dark brown band extends from the cervical sclerites across the dorsal portions of the pleuræ, under the root of the wing, fusing with the dark brown of the postnotum. Halteres dark brown. Legs: coxæ and trochanters light yellow; femora light yellowish brown, tip broadly and abruptly dark brown; tibia light brown, the tip indistinctly darker; tarsi light brown, the tips of the individual segments dark brown. Wings: Uniformly suffused with brown; cells *C* and *Sc* more yellowish-brown; stigma brown; cell 2nd R_1, R_2 and tip of R_3 darker brown; a brown seam on most of the veins and a brown cloud in cell *M* at about four-fifths the length of Cu_1. Venation. (see Fig. a); Rs long, gently arcuated, twice as long as R_{2+3} before *r;* about as long as the basal deflection of Cu_1; R_{2+3} straight, R_2 about two-thirds as long as R_{2+3}. The radial cross-vein connects R_1 with R_{2+3} before its fork, this distance on R_{2+3} between *r* and the fork about equal to the cross-vein *r-m*. Basal deflection of R_{4+5} a trifle longer than *r-m;* cross-vein *m* about twice as long as *r-m;* cell 1st M_2 about pentagonal, its inner face (segment one, M_{1+2}) about as long as the cephalic face (segment two, M_{1+2}); cross-vein *m-cu* obliterated by fusion. Petiole of cell M_1 about as long as this cell. Cu_2 about as long as the deflection of Cu_1.

Abdomen: Tergum, segment 1, yellowish on basal half, dark brown on caudal half and on the sides; segment 2 deep reddish-brown with an indistinct dark brown median stripe and lateral margins; in the

middle an interrupted narrow grey transverse stripe; segments 3—7 similar, but the transverse grey impression is close to the base of the sclerite; segment 8 narrow, its caudal margin with an obtuse median tooth and an obtuse notch on either side (see Fig. t); 9th dark brown; sternites yellow, on segments 4—6 darker, brownish. Upper valves of the ovipositor (u) very slender, the tip not enlarged; 9th sternum long, its caudal margin deeply notched; valves short, acicular (l).

Holotype, ♀, Aguna, Guatemala, Cent. Am. (alt. 1030 ft.) Aug. 6, 1902, (Dr. G. Eisen, coll.)

Type in U. S. Nat. Mus. Coll. (No. 15,075).

The specific name is derived from an ancient tribe of Indians dwelling in Yucatan and the adjoining parts of Guatemala, famous for their high degree of culture and the wonderful structures that they built.

In the size and wing-coloration, this species suggests certain members of the *oblique-fasciata* group, (*oblique-fasciata* Mcqt.; *craveri* Bell.), but differs notably in venational- and leg-characters. In general color it resembles the next species, *fumipennis*, of Peru.

The venation is very like *Holorusia* Loew, and it is quite possible that *maya* may prove to belong to this genus. It is much smaller than *rubiginosa* Loew, which has the wings more uniform, dorsal thoracic stripes not clear, petiole of cell M_1 short, etc.

Tipula fumipennis, sp. n.

Large; thorax dark brown; wings brown; tarsi very long.

♀ Length, about 19 mm.; wing, 23 mm.

Fore leg, femur, 13.6 mm.; tibia, 14.5 mm.; tarsus, about 35 mm.

Hind leg, femur, 13 mm.; tibia, 15.3 mm.; tarsus, about 39 mm.

Head: Anterior prolongation of the front rich reddish-brown; palpi dark brown. Antennæ basal segments reddish; flagellum broken. Front reddish; vertex rich reddish-brown, pale, almost white medially, this pale color including the occiput.

Thorax: Pronotum rich brownish-yellow with two parallel dark brown marks on either side of the median line. Mesonotum, præscutum dark chocolate brown without distinct stripes; scutum and scutellum gradually paler brown, the postnotum yellowish with a very narrow, indistinct median brown line. Pleuræ, propleuræ and cephalic portions of the mesopleuræ dark brown, except a very broad, conspicuous, yellow band running across the dorsal portions of the pleuræ from the pronotal scutellum back to under the wing-basis; remainder of pleuræ yellow. Halteres brown, extreme base of stem yellowish. Legs: coxæ, anterior and middle, dark brown, hind coxæ lighter, yellowish-brown; femora, tibiæ and tarsi brown. Wings: Infumed with brown; cells *C* and *Sc* brighter, yellowish; above the stigma grey; stigma and cell

2d R_1 dark brown; a brown cloud at the origin of Rs; veins broadly margined with the dark-ground color leaving the centers of the cells pale. Venation: Rs rather long, somewhat angulated basally; R_{2+3} about one-third longer than R_2; cross-vein *r* connects R_2 far beyond the fork of R_{2+3}; deflection of R_{4+5} and *r-m* about subequal; sides of the elongate cell 1st M_2 parallel, petiole of cell M_1 short, only about one-third as long as the cell; cross-vein *m-cu* indicated by a point. Cu_2 one-half longer than the basal deflection of Cu_1.

Abdomen: Tergum, brown, 2d segment deeply impressed in the center, except at the median line; lateral margins of the sclerites with a basal yellow triangle; sternites yellow, caudal margins darker, brownish. Ovipositor: Segment 9 short, the valves slender, but flattened blade-like; lower valves, short, very high, blade-like; nearly twice as high as the tergal valves.

Holotype, ♀, Piches and Perene Vs., Peru, 2000–3000 feet, (Pres. by Soc. Geog. de Lima).

Coll. U. S. Nat. Mus. (No. 15,074).

Microtipula, gen. n.

Antennæ elongated in the ♂ and apparently 12-segmented, the flagellar segments very elongated, clothed with a long, pale pubescence; two or three bristles at the base of each segment and, usually, one near the middle. Anterior prolongation of the front short; nasus not distinct. Wings: Sc long extending beyond the origin of Rs to a distance about equal to R_{2+3}; Rs long, gently arcuated, not quite as long as R_3; cross-vein *r* at the fork. R_2 indicated only basally, *its tip atrophied.* Cross-vein *r-m* short, about as long as *r;* cross-vein *m* long, a little less than the basal deflection of M_{1+2}; cross-vein *m-cu* obliterated by the touching of Cu_1 and M_3. Hypopygium complex, penis very long.

Type, M. amazonica, sp. n.

This genus is proposed for a tiny species from Eastern Brazil, which, by its combination of characters, will not fit into any of the existing genera. In its venation (i. e. obliteration of the terminal section of R_2) the species suggests certain *Dolichopezine* genera. In my key to the *Dolichopezini** it would not fit in either of the primary sections; in the *Megistocera* group because of its complex hypopygium or in the *Dolichopeza* group because of its 12-segmented antennæ. It bears a slight resemblance to *Megistomastix* which has a very different hypopygium and 13-segmented antennæ. I prefer to believe it to belong to the *Tipulini.* In Skuse's key† to the Tipuline genera it would run down to *Habromastix* of Australia. However, this genus as well as all the *Tipulini* known to me,

*Psyche; Vol. 19, p. 64 (April, 1912).

†Dipt. Austral.; pt. 8; Tipul. longipalpi (Proc. Linn. Soc. N. S. W.; Vol. 5, (2d series). Feb. 26, 1890; p. 78–81.)

has the terminal section of R_2 more or less preserved.‡ I prefer to believe that the species represents a new genus to which I have applied the above name from the small size of the included form.

Microtipula amazonica, sp. n.

Bluish grey; ♂ antennæ elongated, ♀ short; wings hyaline with brown markings.

♂ Length, 6.2 mm.; wing, 7.2 mm.; antennæ, about 5.5 mm.
Fore leg, femur, 4.4 mm.; tibia, 5.9 mm.; tarsus, 9.4 mm.
Middle leg, femur, 4.5 mm.; tibia, 5.3 mm.
♀ Length, about 6.8 mm.; wing, 7.4 mm.
Fore leg, femur, 4.9 mm.; tibia, 6 mm.
Middle leg, femur, 5.2 mm.; tibia, 5.3 mm.; tarsus, about 9.4 mm.
Hind leg, femur, 4.9 mm.; tibia, 5.4 mm.; tarsus, about 10 mm.

♂ Head: Anterior prolongation of the front short, dark brown; palpi, lighter, yellowish-brown. Antennæ, segments 1—2, yellowish-brown; segment 3 brown; remaining segments dark brownish-black, the segments elongated, not enlarged basally, covered with a long pale pubescence; a few long dark basal bristles. Front brown; vertex and occiput clear bluish-grey.

Thorax: Cervical sclerites bluish-grey; pronotum clear light grey, unmarked. Mesonotum, præscutum greyish with a thick blue-grey bloom, especially thick on the sides and in front, leaving a cuneiform median mark, grey; scutum and scutellum grey; postnotum with a decided blue-grey bloom. Pleuræ bluish-grey. Halteres brown, the knob dark brown. Legs: coxæ yellow, greyish pruinose on the front; trochanters dull yellow; femora yellow, the tip broadly dark brown; tibiæ yellowish brown, the tip darker; tarsi brown. Wings: Subhyaline; cells *C* and *Sc* dark brown; stigma oval, brown, filling in the tip of cell 1st R_1 and the extreme base of cell 2d R_1. Tip of cell 2d R_1, most of cell R_3, cephalic portion of R; median portion of M, and seams along most of the veins paler brown. Venation (see Fig. i) as in the genus.

Abdomen: Tergum, segments 1—2 yellow, dark brown apically and on the sides of the sclerites; 5th dark brown, except the basal third; 6th mostly yellow, darker, almost black, on the apical half and along the lateral margin of the sclerite; 7th black; base of 8th suffused, black. Hypopygium (see Fig. q): 8th sternite rather long, at least twice as long as the 7th and even higher; 8th tergite short, about two-thirds as long as the 7th and not as deep. 9th sternite, viewed from the side, rather short, the ventral margin about straight, the caudal end gently rounded, with an appendage (e); dorsal side with a rounded, chitinized black knob; appendage of the sternite broad, bi-lobed, the ventral lobe with a long flexible, finger-like tip projecting caudad and dorsad; the upper, or cephalic, lobe lying closely appressed to its dorsal margin, elongate-cylindrical, rather fleshy. 9th tergite (in the drawing, Fig. q, 9,

‡ *Pehlkea* End. show a species in which R_2 seems to be present; the venation, apparently, is misinterpreted in the figure. (Zool. Jahrb.; Vol. 32, pt. 1, p. 15.)

the 9th tergite is seen from a dorsal aspect) viewed from above, rectangular with a very deep oval notch, the lateral lobes squarely truncated at the tips, clothed with long hairs, these longest at the apex; a few hairs on the ventral face. Penis (p.) extremely long and slender projecting far beyond the genital chamber and is almost half as long as the whole abdomen.

♀ Like the ♂, but antennæ short; segments 1—5 light yellow, these gradually darkened; pleuræ lighter grey; dark femoral tips not so broad. Abdomen, tergum, segments 1—2, yellow, tip and margin darker; segment 3 almost all black except the base; segments 4—5, yellow except the black lateral margin; segments 6—7 black; tip of abdomen yellow; valves of the ovipositor quite short and blunt.

Holotype, ♂, Igarapé-assú, Para, Brazil, Jan. 29, 1912, (H. S. Parish, coll.)

Allotype, ♀, same locality and collector; Jan. 27, 1912.

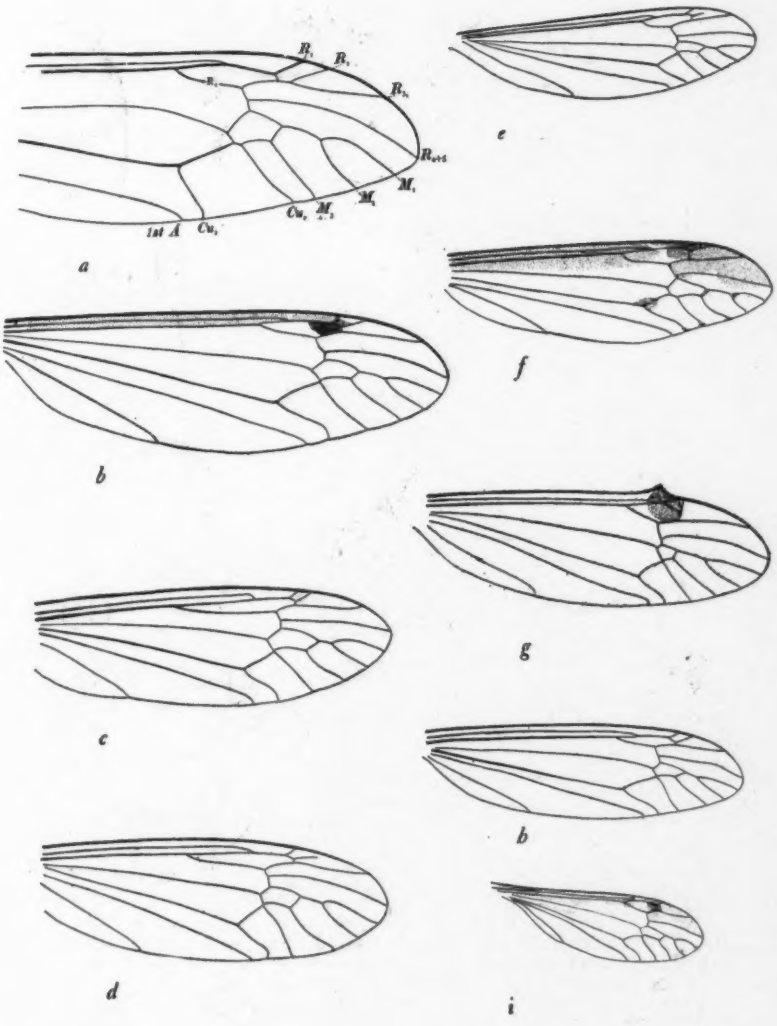
Type in Cornell University Collection.

This insect differs considerably from all the described forms in its small size and blue-grey coloration.

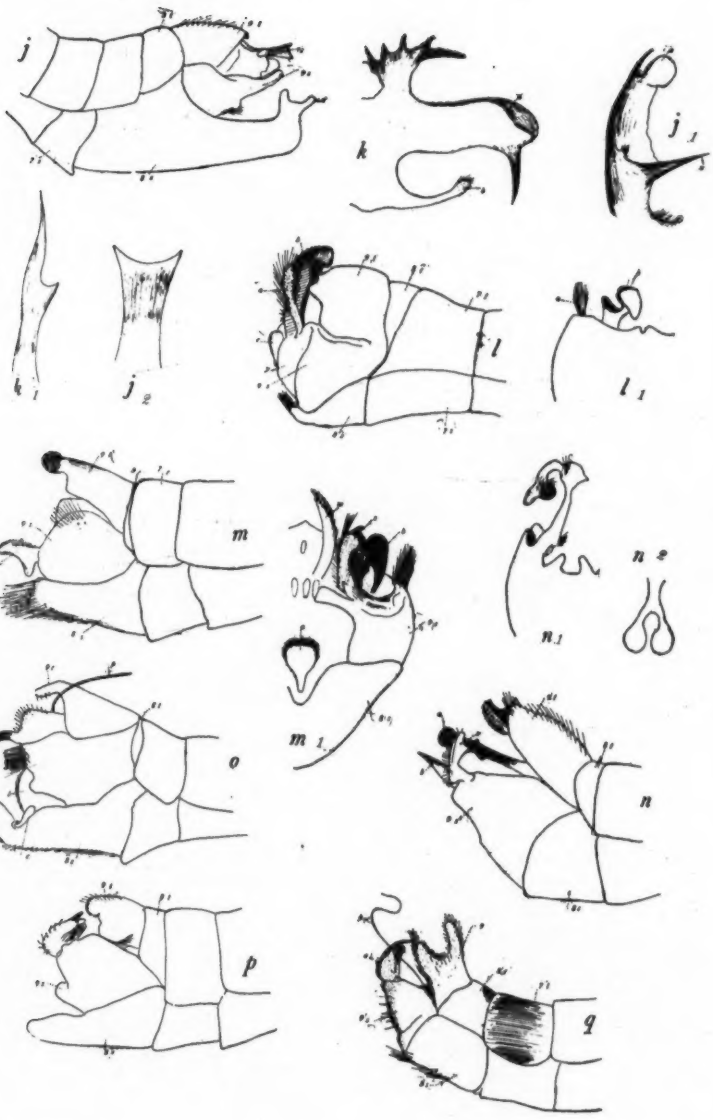
EXPLANATION OF PLATES XXIV, XXV, XXVI.

The wings are all drawn to scale by the projection microscope in Cornell University.

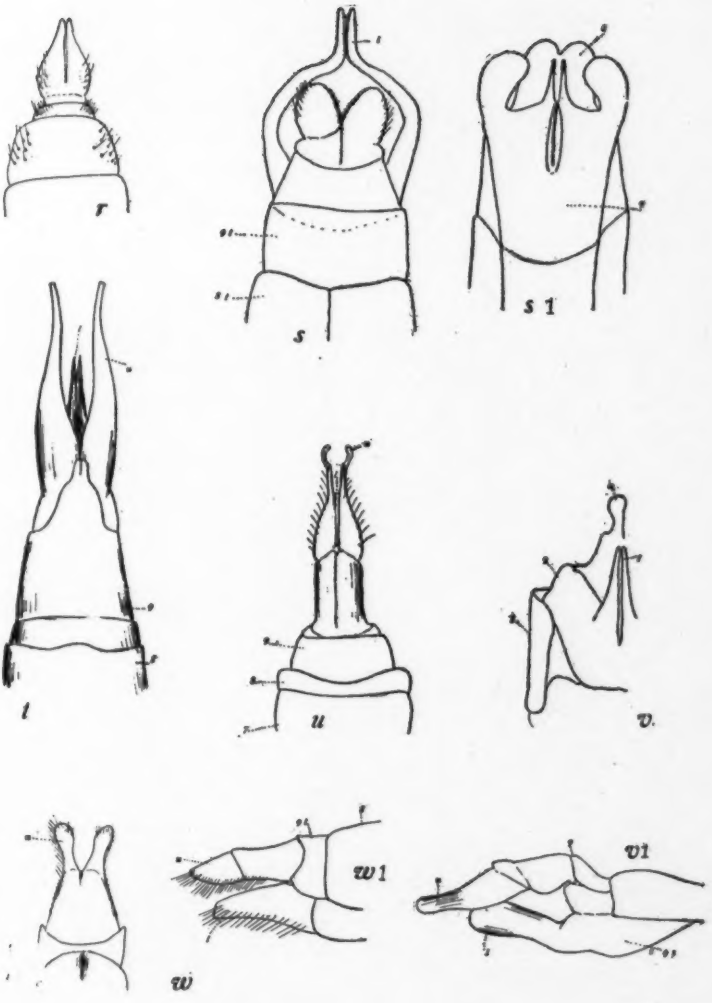
Fig. a. Wing of ♀ *Tipula maya*, sp. n.
Fig. b. Wing of ♀ *Tipula aymara*, sp. n.
Fig. c. Wing of ♂ *Tipula inca*, sp. n.
Fig. d. Wing of ♀ *Tipula atacama*, sp. n.
Fig. e. Wing of ♂ *Tipula guato*, sp. n.
Fig. f. Wing of ♀ *Tipula smithi*, sp. n.
Fig. g. Wing of ♂ *Tipula armatipennis*, sp. n.
Fig. h. Wing of ♂ *Pachyrhina trinidadensis*, sp. n.
Fig. i. Wing of ♀ *Microtipula amazonica*, sp. n.
Fig. j. Hypopygium of *Pachyrhina trinidadensis*. (lateral aspect). 8t, 9t=8th and 9th tergites; 7s, 8s, 9s=7th–9th sternites; *c* equals dorsal apical appendage. j 1=ventral apical appendage enlarged. j. 2 is tip of dorsal apical appendage enlarged.
Fig. k. Hypopygium of *Pachyrhina macrosterna*, sp. n. The ventral apical appendage enlarged. k_1 tip of dorsal apical appendage, enlarged.
Fig. l. Hypopygium of *Tipula inca* (lateral aspect); l_1, (dorsal aspect).
Fig. m. Hypopygium of *Tipula aymara* (lateral aspect)
m_1. Looking into the genital chamber.
Fig. n. Hypopygium of *Tipula parishi*, sp. n. (lateral aspect).
n_1, ventral aspect; n_2, tip of dorsal apical appendage.
Fig. o. Hypopygium of *Tipula armatipennis*. (lateral aspect). p=part of the exserted penis.
Fig. p. Hypopygium of *Tipula guato*. (lateral aspect.)
Fig. q. Hypopygium of *Microtipula amazonica* (lateral aspect). (N. B.—The 9th tergite is shown from a *dorsal* aspect.)
Fig. r. Ovipositor of *Pachyrhina macrosterna*. (dorsal aspect).
Fig. s. Ovipositor of *Tipula aymara* (dorsal aspect). 8t, 9t=8th and 9th tergites. u=upper valve (tergal); l=lower valve (sternal). s_1=ventral aspect.
Fig. t. Ovipositor of *Tipula maya*. (dorsal aspect).
Fig. u. Ovipositor of *Tipula atacama* (dorsal aspect).
Fig. v. Ovipositor of *Tipula armatipennis* (ventral aspect). v_1, lateral aspect, 9s=9th sternite.
Fig. w. Ovipositor of *Tipula smithi*, (dorsal aspect). w_1, lateral aspect.



C. P. Alexander.



C. P. Alexander.



C. P. Alexander.

LIFE HISTORY AND HABITS OF TROGODERMA TARSALE (MELSH.), A MUSEUM PEST.

J. E. WODSEDALEK,
Fellow in Zoology, University of Wisconsin.

CONTENTS.

1. Description.
2. Distribution and Damages.
3. Life History.
4. Moulting.
5. Pupation.
6. Courtship and Mating.
7. Feeding.
8. Variation in Size Among the Adults.
9. Phototactic Reactions and Death Feigning.
10. Results of Experiments on Starvation of the Larvæ.

1. DESCRIPTION.

H. F. Jayne (1882) in his "Revision of the Dermestidæ of the United States" gives the following description of *Trogoderma tarsale*, which he says is identical with *T. inclusum*:

"T. inclusum (Lec.)—Oval, somewhat oblong, black, clothed with moderately long, semi-erect black pubescence. Elytra with four sinuous confluent bands of red, bearing whitish pubescence. Head coarsely and densely punctured, quite sparsely pubescent. Eyes deeply emarginate in front, not very prominent. Antennæ testaceous. Thorax finely punctate, moderately pubescent. Elytra black, with four irregular bands of red, bearing grayish pubescence, the rest with sparse black pubescence, coarsely punctate. Body beneath piceous, coarsely punctate, with cinereous recumbent pubescence. Antennal fossa deep, occupying nearly all the space between the front and lateral margins. Prosternum short, moderately wide, convex, not carinate. Abdominal segments rufous, apical margins paler, pubescent. Legs rufo-testaceous. Length .08—.16 inch; 2—4 mm. Male antennal joints 1 and 2 large, 3—4 very small, 5—11 forming the club, which is not deeply pectinate.

"Female. Antennal joints 1 and 2 large, 3—7 small, 8—11 forming the club. T. tarsale and T. pallipes are identical with this species."

F. H. Snow (1882) gives the following description of the larva and pupa. "In Dr. Hagen's list of Museum pests observed in Cambridge," published in the Proceedings of the Boston Society of Natural History, Vol. XX, I find no mention of the above species, and in order that eastern collectors may guard against its introduction into their cabinets I give the following brief description of its larva and pupa.

LARVA.

"Measurements, when full grown: Length, exclusive of caudal hairs, 5.4 mm.; inclusive of caudal hairs, 8 mm.; breadth, 1.6 mm. Upper dermal surface reddish brown; lower surface vitreous white; entire surface covered with short, soft, yellowish brown hairs; each stigmatic orifice surrounded by a stellate tuft of longer setose hairs, of variable length and of the same color as the general hairy covering. The upper surface of the last three segments is entirely concealed by a dense mass of short, erect dark brown hairs so nearly equal in length as to present the appearance of having been cut off with shears, like the bristles of a very compact brush. The sides of the upper surface of the two preceding segments have a similar covering. The two caudal appendages, which attain one-half the length of the body are noticeably separated when the larva is in motion, often appear to the eye to consist each of a single, stout, elongated bristle, but, under the microscope, are seen to be composed in each case of from twenty to twenty-five hairs.

PUPA.

"Length, 4 mm.; breadth, 2 mm.

"Enclosed within the larval skin, and visible only from above, where the larval skin is longitudinally split open along the median dorsal line from head to anal segment. Abruptly narrows to a point at the anal extremity. Removed from larval skin, the entire surface of the pupa is seen to be covered with short, soft, light yellowish brown hairs, except at the center of dorsal surface which contains three minute transverse incisions or furrows. The anterior margin of each furrow is straight while the posterior margin is curved. Examined under the microscope, both marg ns of each incision are seen to be minutely dentate, but the teeth of the posterior margins are more prominent than those of the anterior margins."

Dr. Snow has apparently obtained and measured larvæ of the average size, for the larvæ attain a much larger size than 5.4 mm. We have collected and raised a large number of specimens which have attained the size of 7 mm., and not infrequently do we obtain larvæ as long as 8 mm., exclusive of the caudal hairs, and 10 mm. including the caudal hairs. The breadth of such specimens is 2.5 mm. Very frequently in the full grown larvæ the upper surface of the last five segments is entirely concealed by the dense mass of hairs and the sides of the upper surface of as many as four of the preceding segments have a similar covering.

The life history of T. tarsale has never been worked out, and a few scattered notes, most of which are subsequently quoted in this paper, comprise the literature on this well known museum pest.

2. Distribution and Damages.

C. V. Riley (1883) says, "It is in fact the most common museum pest in this country and it is strange that Dr. Hagen in his paper on museum pests does not mention it. It is by no means peculiar to the West as the Professor seems to suppose. Here in Washington it is by far the most dangerous enemy to insect collections, and much more frequent than Anthrenus varius. In the field its larva is occasionally found in the cracks of hollow trees and similar situations, feeding on dead insects, but it is far more common in the deserted cells of Pelopoeus, Odynerus, Anthophora and other Hymenoptera, that store their cells with spiders or other insects."

The various notes on this beetle plainly indicate that in the United States it is distributed from coast to coast, and that it is especially abundant in the northern states. As a museum pest no other beetle can do more harm than T. tarsale which when once introduced into a building, is by no means easy to exterminate. Mounted insects especially suffer from the pest and large collections are often wholly destroyed by the larvæ. Here at the University of Wisconsin, as well as in numerous other places, in spite of the great pains taken in frequently inspecting the insect boxes, and in keeping them tightly covered, a large number of useful as well as rare specimens belonging to Dr. William S. Marshall are annually destroyed by the larvæ. Dr. Marshall says that they have even entered Riker mounts and eaten the insects contained therein. Not only do the larvæ attack animal matter such as dried insects, cocoons, furs, skins, wool, feathers, etc., but very frequently they are found devouring vegetable matter as cereals, seeds of all sorts, nuts, and even spices. In the University Drug Collection they were found by the thousands devouring flax and cotton seeds which had been stored away for a long time.

F. H. Chittenden (1895) in a paper on some Dermestidæ says, "T. tarsale Melsh., a common museum pest, was found to infest flax seed, castor beans, and cayenne pepper that had been on exhibition in the museum of the U. S. Dept. of Agric., the larvæ being reared from the eggs deposited in these substances and the adults having been bred from other larvæ feeding on them."

L. O. Howard (1904) in the extracts from correspondence gives the following note: "Dr. George S. Yingling, Tiffin, Ohio, sent to this office (U. S. Dept. of Agric.) with accompanying letter dated May 30, 1903, a glass charm with sterling silver band, inclosing a common French beetle, frequently used as an ornament, together with larva of the cabinet beetle (T. tarsale) which was destroying it. By careful examination of the top of the charm it was seen that there was a crack large enough for the admission of the larva when it was young."

Another note, found in Insect Life (1894) is as follows: "Trogoderma tarsale (Melsh.). Breeding by thousands in silkworm cocoons in the U. S. Gov't Bldg,, a well-known museum pest, probably identical with European species."

3. Life History.

T. tarsale may be found in all stages of development throughout the year in well-heated buildings. Under favorable conditions such as are found in the average museum, with the ordinary room temperature and plenty of food, I have obtained two and a partial third generation in one year. Some of the specimens which hatched in January metamorphosed in June and some of their young in turn matured and laid eggs in October, thus giving rise to a third generation before the end of the year.

The beetles usually pair on the day following their emergence from the pupal skins. The eggs, varying in number from as few as three to as many as sixty, are laid in convenient places from three to five days after copulation. The young larvæ hatch from ten to fourteen days later, the time depending largely on temperature. Under ordinary room temperature they hatch on the average in twelve days. The larvæ, almost immediately after hatching, begin to feed on the material at hand and, as a rule, do not wander unless the food is decidedly poor or scarce. Quite frequently a large number of them hatch in the same insect which had reared the parents and very seldom they desert it until it is almost completely devoured.

In one case eighty-six larvæ hatched in the dry body of a May-beetle (*Lachnosterna*) in which the parents had completed their life history, and, although several other dried insects were present in the same small dish, they were not attacked until the May-beetle was almost completely devoured. The

growth of the larva depends to a considerable extent on temperature and the abundance of food, and it is retarded by cold weather and scarcity of nourishment.

The foregoing factors, however, are not always the cause of slow development. I have noticed that in almost every brood there is a wide variation in the growth of the various specimens under identical external conditions. Very often some specimens attain full size, metamorphose, and produce young long before others are half grown; but not infrequently do these young overtake the other members of their parent group and even reach maturity much sooner under the same conditions. The small, oblong, white eggs are apparently all of the same size and yet some of the larvæ hatching from them seem to be unable to get started in their development. The majority of the specimens, however, mature in about the same length of time, which is from five to six months.

Another very interesting thing which occurred regularly in these studies is the fact that frequently some individuals attain an apparently full size within a comparatively short time, but do not enter the pupal stage for a surprisingly long period thereafter. These larvæ are active, continue to feed, and are normal in their behavior, but there must somewhere be a cause for the sudden halt in their development. We are keeping in the laboratory a large number of larvæ which have been full-grown for over two years, and even very favorable conditions do not seem to effect a metamorphosis. A number of specimens are being kept under different conditions, but thus far nothing entirely conclusive has been obtained.

Summary of Variations in the Life History of Different Individuals of the Same Generation.

1. The adults lay eggs from three to seven days after emergence.
2. The number of eggs laid by different individuals varies from five to sixty-two in number.
3. The eggs hatch in ten to sixteen days, depending largely on temperature.
4. Larval life lasts from five to forty months or more.*
5. The time of pupation is from eleven to seventeen days.
6. The age of adults varies from ten to thirty-two days.

*At present we have a number of live larvæ which have lived forty months.

4. Moulting.

There is an extremely wide variation in the rate of moulting and the number of larval skins shed by the different individuals of this species. In general, under normal conditions, the larvæ moult once in about every two weeks, but there are many peculiarities worthy of mention. The same specimen often sheds its skin very irregularly, sometimes within ten days and then again, under practically the same conditions, not until a period of three weeks or more has elapsed. In general, growing individuals moult more frequently than do those which have attained their full size. Specimens which are slow in their development, as a rule moult less frequently than do the larvæ which develop at the average rate. Not infrequently, however, does a decidedly slow growing specimen moult almost regularly once in every two weeks. The full grown larvæ, previously spoken of, which continue to live for a long time before entering the pupal stage, have, in general, a decidedly slow rate of ecdysis. The average rate is about once in every four weeks and this gradually decreases as the specimen grows older; but here again there is a wide variation, the different specimens moulting once in a period of time which varies from three to nine weeks.

Thus we see that the number of moults is by no means constant. The majority of the specimens which complete their life history in about five months shed their skins from eight to twelve times, whereas, many of the individuals with the prolonged larval history moulted more than twenty times. The greatest number of moults which I have recorded to the present time for any individual is thirty-two, but the number will probably be much greater as these larvæ are still alive and in apparently good condition.

The larvæ never eat their own skins nor the skins of other individuals of this species, even though they may be in a starving condition. This was conclusively proved by placing specimens singly, or in numbers, in glass vials for the purpose of starving the larvæ, and even after many months of starvation, and after the larvæ had moulted several times, the skins were never atacked.

Shortly before moulting the specimen becomes inactive, and a split soon appears in the larval skin along the median dorsal

line; this extends from the head, through the thorax and partly down the abdomen. The larva bends over and assumes a semi-circular position which permits the extrication of the thorax and head. The legs are then pulled out of their coverings and the light colored larva crawls out of the exuvia. Its new, soft, chitinous covering soon hardens and assumes the natural yellowish brown color within a few hours.

C. V. Riley (1883) in an article on the number of moults and length of larval life as influenced by food, says, "Since March 13, 1879, we have kept two larvæ of that common museum pest (Trogoderma tarsale) in a light tin box with an old silkworm cocoon. They were half grown when placed in the box. On Nov. 8, 1880, there were in the box twenty-eight larval skins, all very much of a size, the larvæ having apparently grown but little. The skins were removed and the box closed again as tightly as possible. Recently, or after a lapse of two years, the box was again opened and we found one of the larvæ dead and shriveled up, but the other was living and apparently not changed in appearance. There were fifteen larva skins in the box. We cannot tell when the one larva died, but it is certain that within a little more than three and one-third years two larvæ shed not less than 43 skins, and that one larva did not, during that time, appreciably increase in size.

"We know of no observations which indicate the normal or average length of life or number of molts in either Tenebrio or Trogoderma, but it is safe to assume from what is known, in these respects, of allied species, that in both the instances here referred to, but particularly in the case of Trogoderma, development was retarded by insufficient nutrition and that the frequent molting and slow growth resulted therefrom and were correlated."

My observations and numerous experiments on the starvation of T. tarsale do not corroborate Riley's statement that insufficient nutrition of larvæ in all stages of development show that a lack of nutrition retards the frequency of moulting. Specimens which ordinarily on favorable diet moulted once in two weeks, moulted on the average less than half as frequently when deprived of food.

Summary of Variations in Moulting.

1. Larvæ shed their first skin from four to nine days after hatching.

2. The period between the next succeeding moults, in growing individuals, varies from nine to thirty-six days.

3. The number of moults in different individuals varies from eight to thirty-two or more.*

4. The rate of moulting in full grown larvæ, more than one year old, is once in eighteen to sixty-five days.

5. Specimens under starvation moult once in fourteen to seventy-eight days.

5. Pupation.

When the larva reaches full growth the pupa begins to form within the last larval skin; and from three to five days later the skin splits down the median dorsal line and the light-yellowish pupa is exposed. The period of pupation lasts from eleven to seventeen days, though this may be considerably increased by low temperature, and we have noticed that the males are somewhat more precocious than the females. When the insects are fully developed they emerge through the large dorsal opening of the pupal skin. Should a specimen be forced out of the larval case when not fully matured though capable of locomotion, it invariably returns to its former position within the protective larval skin upon coming in contact with it. The females, after their elytra attain the dark adult color, usually remain in the pupal cases a day or two longer than the males. The average life of the adult insect lasts about three weeks.

6. Courtship and Mating.

The females, on the day of their emergence, avoid the male specimens, but the following day or later they become submissive and copulation takes place. The male on coming in contact with a sexually excited female rubs his antennæ against her abdomen and then quickly turning around brings the point of his abdomen in contact with that of the female. Promiscuous mating is general; a male usually impregnates a number of females and a female usually accepts several males. It might be well in this connection to mention the fact that the sense of smell is not well developed in this species. Experimental work shows that male specimens are unaware of the presence of sexually excited females, even when they are but a very short distance apart.

*Some of the larvæ previously mentioned as having already lived almost three and a half years, have up to the present time moulted thirty-two times.

A large number of females, immediately after the completion of metamorphosis, were placed in separate vials and not allowed to be fertilized. In a single case only were there any eggs laid and those were only three in number. The life of non-pregnant females is, in general, somewhat prolonged. It was also found that extremely small female specimens are sterile.

7. Feeding.

The wide variety of substances upon which this species can subsist has already been mentioned when speaking of their ravages, but it might be well to give the relative value of some of the substances as food for the larvæ. The pests seem to thrive best on dried insects and fish, and although they can live on wool and feathers their growth is decidedly slow when they feed on these materials. A number of specimens immediately after hatching were placed on a feather diet and, although they are now over two years old, they have grown but very little, When they were a year old they were very little larger than the newly hatched individuals, and at the end of the second year of life, they reached a meager size equal to that which specimens fed on insects ordinarily attain in two weeks. Their development on wool is even slower.

F. H. Chittenden (1897) says, "One jar of flaxseed from the museum exhibit of the department is infested chiefly by this common museum pest. Many of the larvæ may be seen through the glass, and large patches of their yellowish-brown gnawings and excrement show where they have been at work. In castor beans a few larvæ were present.

"That these species of Trogoderma can subsist on a vegetable diet is as positive as it is surprising. No other Coleoptera to my knowledge live on oil seeds, and I had nearly arrived at the conclusion that as this form of matter was the nearest approach to animal food available, that these insects could only thrive on such vegetable substances as contain a considerable portion of oleaginous matter. Judge of my astonishment, then, when a few weeks after the discovery of the Trogoderma living in oil seeds, Dr. Howard brought me a box nearly full of cayenne pepper in which were several Trogoderma larvæ. The most careful search failed to show even fragments of that well-known red pepper pest, Sitodrepa panicea, or of any other insect than the dermestid. Subsequently the adult was reared and proved to be Trogoderma tarsale.

"It seeming desirable to ascertain if this species would breed on so pungent a substance as cayenne pepper, a few adults were confined with a quantity of this condiment. In due time larvæ appeared and when examined August 20, or nearly ten weeks from the time the eggs were deposited, were in vigorous condition, the average individual measuring a tenth of an inch in length, or about half that of the full-grown larva. Toward the end of September, while passing through the museum of this department, my attention was attracted by an accumulation of powder and dust about the edges of an exhibit of peanut oil cake, and another of Indian turnip bulbs. A great number of the larvæ and their cast skins were found under and on the under surface of the cakes; also in flour and meal prepared from peanuts. The Indian turnip bulbs were very old and dry, and might have been on exhibition twenty years or more.

"When this insect infests a substance of similar color and consistency to flour and meal only a few larvæ are sufficient, on account of their extraordinary habit of frequently molting, to occasion alarm. In fact, appearances are much worse than the reality. Thus, in a small box of peanut meal in which these larvæ had taken up their abode, about forty larval skins had accumulated when examined September 27, completely covering one-half of the surface of the meal, and giving the impression of a whole colony of the insects.

"After the experiences narrated I was prepared for almost anything, and was expecting that as this species was as nearly omnivorous as the preceding, it would in time be found like them to be granivorous. Having convinced myself by the process of 'reasoning by analogy' that the insect *must* be a grain feeder, I had resolved to experiment with a view of ascertaining if the species would feed upon cereal food. A compulsory delay of a few days saved me the trouble. While the Division of Entomology was moving into new quarters a bag of "Saskatchewan fif" spring wheat, formerly kept in stock for gratuitous distribution, and described on the label as a hard, amber variety with an exceedingly heavy grain, was unearthed, in which the larva of this insect was living, there being present no other insects except a colony of Anthrenus and a single stray Silvanus. In fact, this grain is so hard and flinty that weevils would not flourish on it.

"Soon afterwards I found larvæ in another lot of wheat infested with Silvanus, and in corn containing *Calandra oryza* and other small beetles. About the same time, Mr. Frank Benton brought me larvæ found in beehives, where they apparently fed upon propolis, or bee glue. There are several recorded instances of *Dermestes lardarius* feeding upon wax,* or, more properly speaking, honeycomb, and it is therefore fairly certain that Trogoderma has the same habit, although not previously reported in beehives.

"Among the divisional notes I find one recording the receipt of six larvæ of this species in a box of red pepper, from a correspondent in Utah, November 22, 1882. These larvæ were kept in the box of pepper for a year, at which time fifty-four cast skins were noticed. The box was examined January 14, 1887, or over four years from the time of its receipt, when two larvæ and seventy more cast skins were found, but no trace of beetles, although it had been kept closed, so that it was impossible for either larvæ or adults to escape. It is very obvious that four larvæ, or the beetles that developed from them, had died in the interim and were then devoured by their fellows. In any case, the adult was not reared, and no published statement was made of the larva having been found living in the condiment.

"The capability of this species to breed in other seeds was demonstrated by the discovery of the larvæ living upon "kolu", an edible leguminous seed somewhat resembling a cowpea. The insect had evidently been first attracted by the dead bodies of the original inhabitant of the seeds, the weavil, *Bruchus chinensis*, but had afterwards fed upon the seeds, even hollowing them out and leaving only the empty shells. In a similar manner, larvæ were found, together with those of Attagenus, in millet and pumpkin seeds that had formerly been inhabited by the polyphagous Indian-meal moth, *Plodia interpunctella*."†

In the case of the six larvæ found in the red pepper it is not likely that four of them metamorphosed, because if they had it is certain that they would not have been entirely devoured by

*See Lintner's 6th Report, pp. 122–123; Dubini (L'Ape e il suo Governo, 1881, p. 266.)"

"†Since the preparation of this paper was completed Dr. John Hamilton has recorded the breeding of Trogoderma tarsale in packed figs (Canadian Entomologist, Vol. XXVIII, p. 262, Oct., 1896)."

their fellows. The hard chitinous covering and the elytræ are never completely devoured even by starving specimens. It is much more probable that they died in the larval stage and were later devoured by the other two larvæ; or they might have shrivelled up and darkened, and were thus easily overlooked. That the two larvæ which were present four years later were two of the original six is highly probable. There are several larvæ in our laboratory which were obtained three years ago, when they were full grown, and they have apparently not changed any since.

8. Variation in Size. Among the Adults.

The adult male specimens are smaller, as a rule, than the female insects, but the small individuals are not necessarily always males. There is an extemely wide variation in the sizes of both sexes which in the adult stage vary from 1.25 mm. to 4 mm. in length, the width also being proportionate. It is difficult to determine just what is the cause of such a pronounced difference. Although poor nutrition gives rise, in general, to smaller insects, very small individuals also appear among the large ones which have lived under very favorable conditions. A marked variation in size of the different larvæ of the same brood is apparent within a few days after they hatch. Observations show, however, that the small, slowly developing larvæ do not always give rise to small adults, as in some cases it is merely a matter of taking more time for development.

9. Phototactic Reactions and Death Feigning.

The larvæ immediately after hatching manifest a strong negative reaction to light, concealing themselves in any available shaded area. If placed near a window they at once begin to crawl away from the light, and the reaction is even more pronounced when the specimens are taken into a dark room and a strong light is introduced at one end of the glass dish containing them. This negative phototaxis persists throughout the larval life, and just before the larvæ pass into the pupal stage the reaction becomes even more pronounced. Thus, the pupæ are almost invariably found in dark places which afford them a favorable means of protection.

The adults, both male and female, usually retain their negative response to light after emerging from their pupal skins.

During the period of sexual excitement which follows a day or two later the insects are still negative and the females remain decidedly so until their eggs are safely deposited. Several hours later, or the day following the egg-laying, they gradually become indifferent to light and finally a complete reversal of their former reaction follows. The males, too, become positively phototactic during the last days of their lives. Although ordinarily the adults remain in the cabinets where they had developed till death occurs, we find some occasionally on the windows in the rooms where they make their abode. A number of such specimens were at different times collected and dissected, but in no case were there any eggs found within the bodies of the females. This also indicates that the females lay their eggs before they reverse their reaction to light and desert their places of concealment, and apparently their destruction as a museum pest at this late stage is futile.

The larvæ in all stages of development feign death when disturbed. The period of death feigning, however, is very short, lasting only half a minute at the most and usually only a few seconds. If the disturbance is continued they no longer respond in the same manner. The adult insects when disturbed fold up their legs and antennæ and feign death for a much longer time than do the larvæ; the average feint lasting only about half a minute; but specimens frequently feign death as long as fifteen minutes. This reaction in the adults, too, wears out if the disturbance is repeated.

10. Results of Experiments on Starvation of the Larvæ.

The most interesting feature of the studies on T. tarsale is the extremely long period of time that the larvæ can go without food. Even the newly hatched specimens which never had a morsel of food to eat live as long as four months. Many of the older larvæ, which are being kept in the laboratory, have not had a particle of food during the surprisingly long period of a whole year and are still alive and active; and at this stage of the experiment it is not possible to say just how long the larvæ in various stages of development are able to exist under such conditions.

A large number of larvæ of at least eight representative stages, varying from newly hatched to full grown individuals were collected and placed in covered glass vials, without any food whatsoever, for the purpose of starvation.

Ten larvæ of each representative stage, varying from full grown to newly hatched specimens, were placed in individual vials and also a large number of all the possible combinations in two were made. For example, eight full grown larvæ 7 mm. long were placed in eight different vials and together with each of these was placed one individual of each of the other representative stages. Thus, we had a vial containing two full grown larvæ, one containing a full grown and a larva about 6 mm. in length, and so on down the series with a gradually greater and greater difference in the size of the two larvæ within the same vial, until the last one contained both a full grown and a newly hatched larva.

The same process was repeated with a larva of 6 mm., 5 mm., and so on, to the larva 1 mm. in length, and thus all the possible combinations between the larvæ of practically all sizes were made. The additional purpose of this latter experiment was to determine the extent of cannibalism among the species.

Three such large groups of vials, as that described above, were made and each was placed under somewhat different conditions. One group was exposed to day-light in the laboratory, another was kept continually in the dark, and the third in a box under a constant thirty-five candle power electric light. The last mentioned group of larvæ had a somewhat higher temperature caused by the presence of the electric light in the box.

Measurements of all the individuals were made and a careful record is being kept. The vials are examined regularly and measurements of the several individuals of each representative stage are taken and recorded. A record of the cast skins is also kept; from some of the vials the exuviæ are removed as soon as shed and in others they are allowed to remain continually for the purpose of determining whether the larvæ ever eat them. It was found that the larvæ never devour their own nor the skins of other specimens. There is absolutely no evidence of cannibalism among the larvæ; even the full grown starving specimens never attack the much smaller individuals. Practically all of the insects shed their skins shortly after they were placed without food; but between the other following ecdyses a period much longer than the normal elapsed. Careful measurements soon revealed the surprising fact that the larvæ were actually decreasing in size. In all

three of the groups many of the specimens which were less than half grown, or 3 mm. in length, at the beginning of the experiment, had reduced within about six or seven months to the minimum size of 1 mm. in length. Many of the full grown larvæ which were 7 mm. in length have fallen back to less than half this size within one year of starvation; others decrease less rapidly, some having lost only 2 mm. during the same long time. The larvæ under the constant electric light had a somewhat higher temperature and decreased more rapidly than did those of either of the other two groups; Even some of the full grown larvæ of this group had actually reduced their size within eleven months to practically the same measurements they had upon hatching, about 1 mm., and then finally died. The results of these experiments will be published in detail as soon as they are completed.

I wish to express my thanks to Prof. William S. Marshall for his suggestions and kind criticisms in preparing this paper.

Zoological Laboratory, Univ. of Wisconsin,
October 15, 1912.

REFERENCES.

Chittenden, F. H.
1895. Herbivorous Habits of Certain Dermestidæ. Proc. Ass. Econ. Ent., Bull. No. 2, n. s., Div. Ent., U. S. Dept. Agr., pp. 36, 37.
1897. Granivorous and Other Habits of Certain Dermestidæ. Bull. No. 8, n. s., Div. Ent., U. S. Dept. Agr., pp. 14–24, 1 Fig.

Howard, L. O.
1904. Extract from Correspondence. Bull. No. 44, Div. Ent., U. S. Dept. Agr., April, pp. 90–99.

Jayne, H. F.
1882. Revision of the Dermestidæ of the United States. Proc. Amer. Philos. Soc., Vol. XX.

Riley, C. V.
1883. Trogoderma tarsale as a Museum Pest. Amer. Nat., Vol. 17, p. 199.
1883. Number of Moults and Length of Larval Life as Influenced by Food. Amer. Nat., Vol. 17, pp. 547–548.

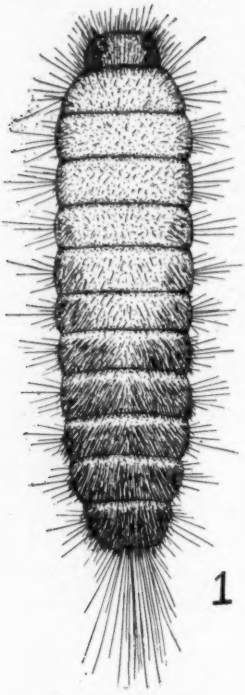
Snow, F. H.
1882. A New Museum Pest. Psyche, Vol. 3, pp. 351–352.

1894. Insect Life, Vol. 6, p. 226.

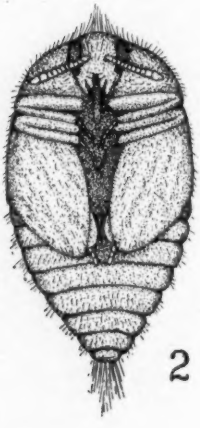
EXPLANATION OF PLATE XXVII.

All drawings (except Fig. 4) made with a camera lucida. x 10. Stages in the Life History of Trogoderma tarsale (Melsh.)

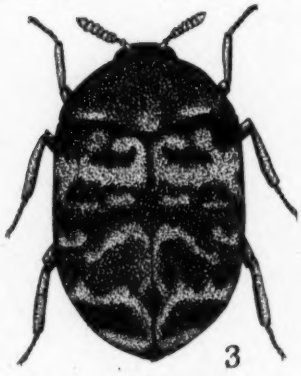
Fig. 1. A full grown larva.
Fig. 2. Ventral view of pupa removed from the pupal case.
Fig. 3. Adult male.
Fig. 4. Male and female antennæ.
Fig. 5. Dorsal view of pupa as seen through the split in the pupal skin.



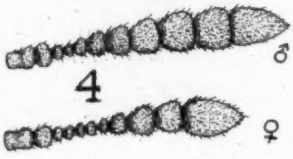
1



2



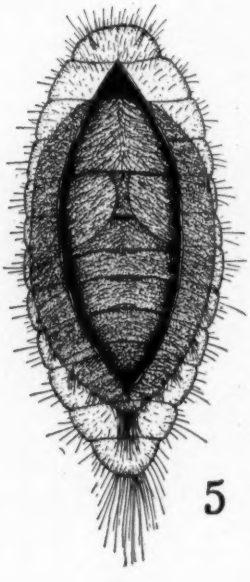
3



♂

4

♀



5

J. E. Wodsedalek.

THE INTERNAL ANATOMY OF ICERYA PURCHASI.

CARL E. JOHNSTON, Stanford University, California.

The external anatomy, habits and life history of *Icerya purchasi* are well known through the work of Riley, Comstock and others. The present paper contains notes on the internal anatomy of the female, certain details of which depart from any Coccid anatomy previously described.

This work was done in the Entomological Laboratory of Stanford University.

MOUTH PARTS.

(Plate XXVIII, Fig. 1.)

The essential features of the mouth parts of *Icerya purchasi* are the internal chitinous framework, pharynx, and labial cavity, the buccal setæ, and the external labium. The framework lies on the ventral body wall in a median line opposite the bases of the fore legs, only the posterior ventral side being exposed. The bases of the setæ and the pharynx are contained in the typical Coccid chitinized box-like structure, lying between two indefinitely five-sided areas. The lower plane, or area inferior, is considerably the larger. It is bounded on the front by the arcus formed by the fusion of the interior end of the costæ superiores and the costæ inferiores, and on the side by the right and left costæ inferiores, each of these, consisting of two parts, articulating with it. (Pl. XXVIII, fig. 1 b). The posterior end of each costa inferior joins with the corresponding part of each costa superior to form the clavus. (Pl. XXVIII, fig. 1 u).

On each side, joining the costæ as shown at the point b in fig. 1 of Plate XXVIII, and running ventrad toward the costæ superiores, is a chitinous piece, L, which branches just before reaching these costæ. One branch goes ventrad a short distance, lying free in the cavity; the other branch extends a little way caudad and serves as a support for the conical base of one of the setæ.

The upper plane, or area superior, is bounded on the front by the same fused arcus that bounds the lower area. On the sides it is bounded by the costæ superiores, each of which

consists of an anterior and posterior part, fused or articulated at the point o. A heavily chitinized plate, t, connects the entire lower halves of the costæ superiores.

The setæ consist of four very long, slender, solid rods, the bases of each being enlarged and forming an elongated cone, s, — s. Two of these cones lie on either side of the box, one pair being supported by branches from the piece l. The other pair of cones is supported by a heavily chitinized elongated structure, x, arising from the posterior surface (base) of the framework, and standing up within it, its anterior end being just above the point of articulation of the upper and lower halves of the costæ, and lying free within the cavity. Between the conical bases of the setæ and arising from the clavus is a short cone-shaped organ, lying just below the pharynx and œsophagus and possibly serving to protect them.

The four setæ come together at the clavus and are appressed to form a tube. This tube then passes backward into a long transparent pocket, the labial cavity, c. This pouch lies in the body cavity next to the ventral body wall, running back to the fourth segment. The tube extends the entire length of the labial cavity and forms a loop, returning to the point of entrance and passing out of the body through the labium.

The labium, z, is an external organ and does not have much movement except a slight backward and forward motion. It is a heavily chitinized, more or less heart-shaped structure, the lateral halves of which, originally separate, have been fused together. The setæ pass through the center and upper part of the labium and pass out of the lower or apical end. The labium is heavily musculated, and at its external opening a cross section shows a ridged or serrated structure.

ALIMENTARY CANAL.

(Plate XXVIII, Figs. 3 and 4.)

The œsophagus is long and slender, widening out as it approaches the proventriculus. It is strongly musculated with circular muscles, the inner wall consisting of a layer of small single-nucleated cells. Passing upward and backward it goes through the œsophageal commissures and enlarges into the proventriculus. Back of the proventriculus is the ventriculus proper.

The parent digestive cells of the ventriculus contain as many as five nuclei each, and there can be seen free cells in the ventriculus which have been given off from the attached parent cells. These free cells possibly assist in digesting the food.

The ventriculus runs back a short distance farther to about the junction of the sixth and seventh segments, and then turns abruptly and runs forward well past the junction of the œsophagus and the proventriculus. Here it makes a couple of turns, going backward and then forward to its junction with the ileum, at which point it widens out for a short distance.

The ileum is very short and is small in diameter. The colon is largest at its anterior end and then, growing smaller, runs backward and finally merges into the rectum. The rectum is in the seventh abdominal segment, and the anal opening is on the dorsal surface of this segment.

Salivary Glands. (Plate XXVIII, fig. 2).

The salivary glands are located on each side of the chitinized box of the mouthparts. There is one gland on each side, made up of three spherical cells, heavily nucleated. A duct, carrying the secretion, leads from each gland to the mouth.

Malpighian Tubules. (Plate XXVIII, fig. 3).

The malpighian tubules are three in number, convuluted and considerably longer than the intestine from its point of junction with the œsophagus to its most posterior point. The tubules are very dense, with heavily nucleated cells, and besides being convuluted, are curved to a certain extent at their posterior ends, and seem to be fastened to the ventriculus by a few very fine muscular fibres.

RESPIRATORY SYSTEM.

(Plate XXVIII, Fig. 7.)

There are two pairs of spiracles, the first pair being located on the ventral side of the prothorax, posterior to the anterior pair of legs, and the second pair between the meso- and metathorax on the ventral side posterior to the middle pair of legs. A groove extends from each spiracle to the margin.

Each spiracle has a somewhat kidney-shaped funnel-like opening, very strongly chitinized. A large trachea extends in from each spiracle on either side; this soon divides into three main tracheæ in the anterior system and four in the posterior

system. The anterior system of tracheæ soon re-divides many times. One of the secondary divisions forms, with the similar division of the opposite trachea, a transverse trunk just behind the chitinized box supporting the mouthparts. The other branches go to the antennæ and to the fore and mid legs and anterior part of the body.

From each spiracle of the posterior system four branches are given off, two very large, one smaller and one very small. These subdivide many times but, as far as could be determined, there is no connecting trunk between the two posterior tracheal systems. These posterior systems supply the hind legs, alimentary canal, reproductive system and all of the posterior portion of the body.

CIRCULATORY SYSTEM.

No definite dorsal vessel was found. The blood probably simply circulates through the open body cavity.

NERVOUS SYSTEM.

The nervous system consists of two large fused ganglia, lying ventrally in a median position and several nerves connected with these ganglia. The cephalic ganglion lies above and largely in front of the framework of the mouthparts. Its anterior and principal portion is large and triangular in shape and is distinctly bilaterally depressed into two large lobes. The posterior portion of the ganglion greatly diminishes in size and divides into two commissures, passing around the œsophagus.

From the under part of the central and most anterior portion of each lobe in the anterior part of the cephalic ganglion a small nerve runs to the antenna and from the anterior angles of each lobe and laterad of each antennal nerve the optic nerves proceed to the eyes.

The œsophageal commissures continue backward, passing above the fused arcus and gradually re-uniting and enlarging into the thoracic or infra-œsophageal ganglion. The thoracic ganglion is slightly depressed above the mid-dorsal and mid-ventral line. There are four very obvious transverse divisions, making in all four double-lobed parts or divisions of the thoracic ganglion. The posterior division is somewhat narrower and possibly more plainly divided than are the three

preceding ganglia. These "lines of division" are really, probably, lines of fusion of pairs of ventral ganglia distinct in embryonic life.

No nerves were found issuing from the first ganglion. From the second and third thoracic ganglia, rather large and prominent nerves proceed at nearly right angles. From the posterior division, two long, slender nerves extend back into the sixth or seventh abdominal segment, dividing along their course into three or four smaller nerves which run backward parallel to these posterior divisions.

REPRODUCTIVE ORGANS.

(Plate XXVIII, Fig. 5.)

The reproductive organs of the female consist of the ovaries, oviduct, vagina, spermatheca and vulva. The ovaries are very curiously developed in this insect. Instead of the customary pair of separate ones, lying one on either side of the alimentary canal and running caudad to unite in a common duct, ending in the vagina, the two ovaries are found united. No anterior division can be found and the whole forms a loop united by a continuous membrane. The posterior ends unite, forming the vagina, and run ventrad to the external opening. This oviduct widens and narrows with no apparent regularity. The ovarioles are fastened to the oviduct throughout its anterior half. They are not found on the posterior ends of the loop, but the point where they stop is not clearly defined. In some specimens it is much nearer the vagina than in others. The ovarioles are given off from the oviduct either as single expansions connected by a long, slender tube, or in bunches or groups of from two to eight or ten. Usually the connecting tube is longer where there is but a single ovariole than where there are several. The larger ovarioles are all given off singly, while the clusters occur as a number of much smaller ovarioles. Each ovariole, no matter what its size may be, is more or less oval in shape, and at its distal end there is always a constriction and a head, fitting the larger part of the ovariole like a circular cap.

The spermatheca is a transparent pouch given off midway of the vagina. The vulva is a strongly musculated, oval, external orifice.

WAX GLANDS.

(Plate XXVIII, Fig. 6.)

The wax glands are scattered pretty well over the body, especially on the dorsal aspect of the thorax and on the dorsal and lateral aspect of the last three segments of the abdomen.

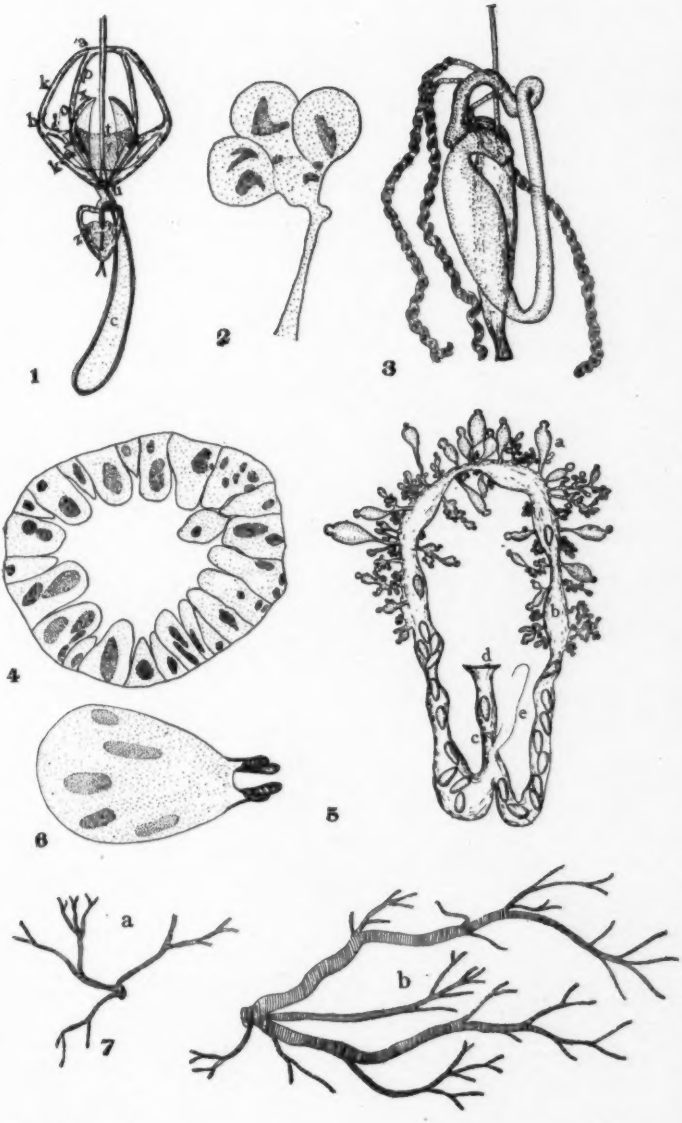
There are two kinds of glands, the most numerous consisting of a single more or less balloon-shaped or oval cell with an external chitinized pore. This cell contains several nuclei and very faint longitudinal divisions, each division containing one of these nuclei. The external pore is very heavily chitinized, and is more or less horse-shoe-shaped with semi-circular chitinized structures lying on each side of the horse shoe.

The second kind of wax glands has the chitinized pore or tubercle prolonged into a long, stout spine at the base of which is a cup-shaped secretory gland.

EXPLANATION OF PLATE XXVIII.

Anatomy of **Icerya purchasi.**

Fig. 1. Mouthparts.
Fig. 2. Salivary glands.
Fig. 3. Alimentary canal and malpighian tubules.
Fig. 4. Cross section of ventriculus.
Fig. 5. Reproductive system.
Fig. 6. Wax gland.
Fig. 7. Respiratory system; a, anterior aspircle and trachæa; b, posterior spiracle and trachæa.



C. E. Johnston.

DEATH FEIGNING IN CONOTRACHELUS NENUPHAR HERBST.

WILSON P. GEE and F. H. LATHROP.

Peculiarities in behavior of insects have many times been used with distinct advantage in the control of injurious forms. The heliotropic reaction of moths—that is, their tendency to fly towards the light—has given rise to the trap lantern; and a knowledge of the nocturnal habits of the malarial and yellow fever mosquitoes has made it possible for the diseases caused by these insects to be avoided by housing oneself during their period of activity. One of the most striking cases of the direct economic application of an instinct in insects is that of death feigning or "playing possum" in the plum curculio, *Conotrachelus nenuphar*, Herbst.

It is true that the introduction of arsenical sprays marks an epoch in the control of the curculio, and quite deservedly has caused the old method of "jarring" to be largely superseded by the newer one of spraying. The practice of "jarring", however, is still in vogue in sections where the spray pump has not come into general use. Therefore, a study of the features of the instinct is of interest, not only from the biological point of view, but also due to the fact that at a not remote time it provided the most effective measure of control for the plum curculio.

In speaking of the preventive measures for lessening the injury of this pest, Johnson and Girault (8: 1906), of the Bureau of Entomology, U. S. Department of Agriculture, have the following to say: "Among these jarring is the method which is perhaps in most general use in protecting plums and peaches, and by many orchardists it is believed to give the best results. Early observations upon the plum curculio showed that this insect has a habit of falling to the ground and "playing possum" when disturbed. A knowledge of this habit has led to the capture of the beetles on sheets, held or spread beneath the trees, the trees being jarred by a sudden forceful blow struck with a padded pole or mallet in order to dislodge the beetles." A field test of the efficiency of the method made by these same men in a Georgia orchard showed "that the amount of the

curculio damage in this orchard for the season was placed at about four per cent of the crop. In an adjacent orchard of 130,000 peach trees not jarred, curculio injury was placed at forty per cent of the crop."

Owing to these facts, the writers considered it worth while to devote their leisure time during the past summer to a study of some of the general features of this exceedingly interesting mode of behavior. The work of Holmes (5, 6, 7) on the water scorpion, *Ranatra quadri-dentata*, and of the Severins (10) on *Belostoma flumineum* and *Nepa apiculata* make an exhaustive study of little significance. The work embodied in this paper was done at Clemson College, S. C., during the latter part of June and the month of July, and consequently upon forms which had emerged at the earliest only a few weeks before.

Death Feigning Attitudes.

It was found possible to produce the feint by three methods, and when one was not successful, the others were employed. The one most used is the same as that by which it is evoked in the natural environment of the insect—by dropping it from some distance in the air. When the insect is allowed to fall to the top surface of a table from a height of a few inches, the feint seems to be as effectively produced, usually, as when dropped through a space of several feet. By pressing the lateral surfaces of the abdomen and thorax, at short intervals, either by means of the fingers or forceps, the same effect may be secured. A third method is that of grasping the insect between the thumb and forefinger and blowing a sudden breath upon the ventral surface of the abdomen and thorax.

There are two distinct postures assumed by the insect in feigning death. In the first (fig. 1, A), the insect draws the thoracic appendages closely against the ventral surface of the body. The first pair of legs extend forward and are tightly pressed against each side of the proboscis. The second and third pairs are closely flexed, and held securely against the ventral surface of the thorax and abdomen. In the second position, the legs are folded closely together and held somewhat perpendicular to the line of the body (fig. 1, B). The tarsi of the first two pairs of legs are drawn tightly against the tibiæ; but in the last pair they are held approximately parallel to the ventral surface of the thorax. The first position is usually the

one more easily evoked; the second being given upon more vigorous stimulation. However, there seems to be considerable individual variation in this respect, some curculios assuming the second position more readily than the first. It was found possible to elicit the two types of response in the several individuals experimented on in this connection.

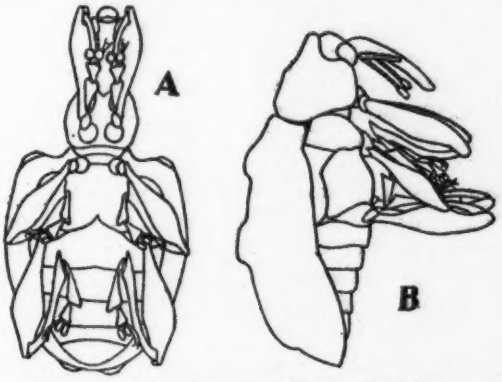


Figure 1. Attitudes assumed in the death feint.

Several specimens were starved to death, and others killed by a slow poisoning. All of these assumed a position very similar to that of the death feint indicated in fig. 1, B. The only difference to be noted was that in most cases, the tips of the tibiæ were farther apart, the legs being held not quite so perpendicular to the ventral surface of the thorax. This simulation of the natural death attitude in the death feint is in accord with the results of Kirby and Spence (9), who in the case of the dung-chafer, *Geotrupes sterocarius* found the same thing to occur. While not true in *Belostoma*, yet it is very closely parallel to what the Severins (10) found in *Nepa*, where "it becomes at times impossible to distinguish with the eye alone, a death feigning specimen from one that is really dead." However, in the majority of forms which have been studied, as recorded by Darwin (2) and other workers, the death attitude is found to be quite distinct in character from that assumed in the death feint.

Duration of Successive Death Feints.

It was the experience of Fabre (4) that when a large beetle, *Scarites gigas*, Fabre was put into five successive death feints, they lasted 17 minutes, then 20, 25, 33, and 50 minutes respectively. From this behavior, he draws the conclusion: Ils nous qu'en général le *Scarite* prolonge advantage sa pose inerte à mesure que l'epreuve se répète." The results of the Severins (10), however, do not agree with those of Fabre. They find a "wide variability in the duration of the first five feints in the different individuals under uniform conditions", and also "that the duration of successive death feints in each individual also varies."

Our experiments show results much more in accord with the Severins than with Fabre as observation of the following table will serve to show. Quite a wide range of variation is here to be seen, three of the six individuals showing a less duration of response in the fifth than in the first feint into which they were placed.

TABLE I.

DURATION IN MINUTES OF FIRST FIVE SUCCESSIVE DEATH FEINTS IN SIX CURCULIOS.

A	B	C	D	E	F	AVERAGES
1.	10.	8.	6.	6.	3.	5.66
12.	2.	11.	2.	8.5	5.5	6.83
2.5	5.5	5.5	2.5	2.	9.	4.66
3.	1.5	2.5	1.	1.	10.	3.16
8.	3.	1.5	1.	7.	28.	8.

Six specimens were tested in order to determine the length of time the feint might be successively induced. Holmes (6) found in the case of ten *Ranatras* successively put into death feints, that these were continued without interruption from 9 a. m. to 5 p. m., when the last specimen refused to feign longer. The Severins (10) found it possible in the case of *Belostoma* to induce feints successively for a total of five hours. The responses of the curculio were very much less pronounced than was the case of these forms. Feints could not be elicited

successively for a period of greater length than two hours, fifty-three representing the largest number of feints successively produced in a single individual. The feints, after the first several, tended to show a decrease in duration, some of them continuing for only a few seconds. Finally the curculio refused to feign longer, no matter how treated, and in many cases made strenuous efforts to fly away.

The muscular system of the insect, while in the death feint, is in a tensely contracted condition. When held in a pair of forceps by the tip of one tibia, the entire body may be held out horizontally without signs of bending or movement on the part of the curculio. After a short time, however, the weight of the body causes a gradual relaxation of the leg muscles, and the animal is inclined downwards. Holmes (7) found the same thing to hold true in *Ranatra*, and says: "It is as if a man were seized below the knee and held out straight, face upward, without causing the knee to bend, only the legs of a *Ranatra* are several times more slender than those of the most attenuated of the human species, and the muscular tension which the insect maintains must therefore be intense." Undoubtedly, the acclimatisation of the insect to the extent that failure to respond with the death feint occurs after several successive periods of it have been passed through is to be explained in part at least as due to the muscular fatigue resulting from this rigidly contracted condition.

Effect of Temperatures on the Death Feint.

According to DeGeer (3), from his work on a small timber-boring beetle, *Anobrium pertinax*, "you may maim them, pull them limb from limb, roast them alive over a slow fire, but you will not gain your end; not a joint will they move, nor show by the least symptom that they suffer pain." In order to determine whether such a condition held in *Conotrachelus nenuphar*, many feigning specimens were placed on a thin piece of glass and gradually heated over the flame of an alcohol lamp. Though this experiment was repeated many times, the insects without a single exception, recovered activity as soon as the glass became heated. Individuals with the abdomen removed, others consisting of only the head and prothorax, and still others with all of the appendages removed, were placed in the

death feint and subjected to the same conditions as the normal ones, but not a one of them was found which would allow itself to be injured by the heat before attempting to escape.

Several specimens were taken and the time of six successive death feints was determined, and found to compare very closely with the results given in Table 1. These individuals were then placed, ventral surface uppermost, on a thin glass plate which was in contact with a block of ice. For approximately one minute the curculios made no movement. Then the abdomen was raised upwards out of the wing covers, as though to remove it from contact with the cold glass. The wing covers were then slowly spread away from under the body until they were well open. The legs were partially relaxed, but the movement was so gradual as to be almost imperceptible. This position was continued for a short time, and then the wing covers were drawn to their former position, the legs again becoming rigidly contracted. The insects were again motionless, and continued so until removal from the glass, forty minutes later. After a short interval had elapsed from the time of their removal, activity was manifested almost simultaneously among them. It was now found very difficult to induce these individuals to feign death.

A mixture of crushed ice and ammonium nitrate was now prepared and test tubes containing feigning curculios were placed in it. No movement whatever was manifested from the time they were placed in the test tube. When removed thirty minutes later, they were found to have sustained death as the result of the low temperatures (–15°C to –20°C) produced by this mixture.

These results in general agree with those of Fabre (4) on the Buprestid, *Capnoides tenebrinionis* Lin; and Holmes (6) on *Ranatra*, who find that cold has the effect of increasing the duration of the death feint to a marked degree.

Influence of Gases on Death Feint.

Many curculios were induced to feign death, and test tubes containing a wad of cotton saturated with ether were slowly placed over them. Without exception, the curculios revived almost instantly, many of them recovering before the tube touched the table. The same experiment was made with

chloroform, carbon di-sulphide, and carbon-di-oxide with similar results. Mutilated specimens put into the death feint were also tested and it was found that the most of them responded in the same manner. Thus in the case of the gases, as in that of heat, we see an adaptive feature in the nature of the instinct that tends to remove the animal from a stimulus of such a character as would result in injury to the organism.

Effect of Mutilations.

Holmes (6) found in *Ranatra*, that the appendages could be removed one by one, while the animal was in the death feint without evoking any response from the insect. The Severins (10) found in *Belostoma* that "if one of the limbs be snipped in two with a pair of fine scissors, the bug may not respond at all, or the limb may twitch or quiver, or the insect may right itself and scramble eagerly to get away. One or two repetitions of this experiment with those specimens which did not come out of the death feint immediately after the cut was made were sufficient to bring them out." In the case of *Nepa*, however, the results were more in accord with those reported on *Ranatra*.

The appendages of eight feigning curculios were removed one by one. With the exception of two of these curculios, every one of them showed absolutely no signs of recovery from the feint until several minutes after the operation. In the case of these two, recovering activity took place immediately after severing the first appendage. They were very easily made to feign again, and the operation proceeded without any apparent objection on their part.

Seven feigning individuals were decapitated with a pair of small, sharp scissors. The result was an immediate relaxation of the legs followed by efforts on the part of the body to right itself. In one case the wings were outstretched as though attempting to fly. The bodies were placed in the normal position with the result, however, that only two of them walked in a co-ordinated manner, and these for only a short time. This behavior is no doubt due to the shock effects of the operation. It was found possible to induce the death feint in these decapitated specimens, but with much more difficulty and with a shorter period in the duration of the response than was the case in the normal specimens.

Several specimens were placed in the death feint, and the abdomen of each was clipped away. No movement was made except a slight twitching of the tarsi in a few of the specimens. The insects remained in the feigning attitude for the normal length of time, and upon recovering activity walked about in a perfectly co-ordinated manner, except for the difficulty of balancing the body. They were thrown into the feint in this condition with about as much readiness as were the normal specimens.

The next operation performed was to sever the body between the prothorax and the mesothorax. The result without exception was an instant manifestation of activity on the part of the body, in some cases the wings becoming extended as if to fly. The head and prothorax, however, showed no shock effects of the operation, but remained in the feint for some time afterwards. This portion of the body could be readily induced to feign death, but the posterior part only to a very slight degree even upon vigorous stimulation. These results in general accord with those of investigators on other forms.

Nature of the Instinct.

The instinct of feigning death occurs in almost all of the orders of insects. While it is perhaps within this group that it reaches its most marked development, it is to be found to a slight extent in all of the higher phyla of the animal kingdom. It has been studied by Holmes in the amphipod crustaceans, and has been found by Andrews (1) in the breeding habits of the cray-fish. It occurs rarely among the fishes, and to a certain extent in the amphibians. In varying degrees, it is found expressed in the reptiles and birds; while among the mammals, from the behavior of the opossum, the common synonym "playing possum" has come to be derived.

It is Holmes' (5) conclusion from his work on the amphipod, *Talorchestia longicornis*, "that the death feigning instinct of *Talorchestia longicornis* is an instinct which has its roots in the thigmotactic response common among amphipods." The Severins (10) say: "Among aquatic *Hemiptera*, the death feint may have arisen out of positively thigmotactic propensities which are manifested to such a marked degree by various members of the families *Belostomatidæ and Nepidæ*." It is evident without statement, from the results discussed in this

paper, that the behavior of *Conotrachelus* serves to corroborate these conclusions and it is a striking fact that the response can be secured upon such slight contact stimulus, scarcely more than a touch being necessary to elicit a well marked death feint. The fact that the body deprived of its head, can be induced to give the response, removes the greater part of the psychic speculation in regard to the nature of the instinct.

Just what the value of it to the curculio in its native environment may be is largely a matter for conjecture; but that it has been used very effectively in combatting this common and injurious insect remains an incontrovertible fact.

It is with grateful appreciation that the writers here express their indebtedness to Dr. S. J. Holmes for the valuable suggestions arising from his critical reading of this article.

BIBLIOGRAPHY.

1. **Andrews, E. A.**
Breeding habits of the crayfish. Amer. Nat. XXXVIII, 1904. pp. 165–206.

2. **Darwin, C.**
Appendix in Romanes, G. J. Mental Evolution in Animals, 1884.

3. **DeGeer, C.**
Memoirs pour servir a l'histoire des insectes. IV, p. 229.

4. **Fabre, J. H.**
Souvenirs Entomologiques. Paris. 7e series pp. 14–27.

5. **Holmes, S. J.**
Death feigning in terrestrial amphipods. Biol. Bull. IV, pp. 191–6. 1903.

6. ———
Death feigning in Ranatra. Journ. Comp. Neur. and Psychol. XV, 1906. pp. 305–349.

7. ———
The Instinct of Feigning Death. Pop. Sci. Monthly, LXXII, 1908. pp. 179–185.

8. **Johnson and Girault.**
The plum curculio. Circ. 73. Bu. of Entomol. U. S. Dept. Agric. 1906.

9. **Kirby, W. and Spence, W.**
An Introduction to Entomology. Sixth London Edition. pp. 447–9.

10. **Severin, H. H. P. and Severin, H. C.**
An experimental study on the death-feigning of Belostoma (Zaitha Aucct.) flumineum Say, and Nepa apiculata Uhler. Animal Behav. Monographs I. No. 3, 1911. pp. 1–44.

THE FLIGHT OF TWO THOUSAND MARKED MALE MEDITERRANEAN FRUIT FLIES (CERATITIS CAPITATA WIED.).

HENRY H. P. SEVERIN, Ph. D., Honorary Fellow, University of Wisconsin, and WILLIAM J. HARTUNG, B. S.

Mally (1, p. 8) Entomologist for the Eastern Province, Cape Colony, South Africa, discusses the migration of the adult Mediterranean fruit fly as follows: "There is no evidence to show how far the adults will travel in their search for food. Some observers think they migrate but very little, citing instances where well-kept premises have been fairly free although in close proximity to neglected and badly infested ones. Under such conditions there is no necessity for migration, ample food-supply being already at hand. There is no clear evidence to show how they get to new orchards on farms where fruit trees have never been grown before. Men who have laid out new orchards say that the 'maggot' was in evidence the first time the trees came into bearing. * * * It is a popular belief that the flies come in from the veld. The most unrelenting search has failed to demonstrate their presence in bush or veld 500 yards from an orchard."

"Prevailing winds are perhaps the most potent factor. How far the flies are liable to be carried by the wind it is impossible to say. One would hardly expect that they would be blown very far at once. It seems easily within the range of possibility that they should be involuntarily caught up by the wind when they attempt to fly and lodge on a bush or in the veld some distance away; and then be caught up again and carried still farther, and so on indefinitely. There is little doubt that certain Aphididæ do make use of the wind in migrating to their secondary host plant, but I have found nothing to indicate the presence of the same trait in the fruit fly."

Newman 2, (p. 7) Entomologist of Western Australia writes as follows concerning the migration of the Mediterranean fruit fly: "This fly is not an insect that migrates any great distance. As long as a food supply is available, it remains in an orchard. I have known instances where one orchard was swarming with the pest and the one next door or on the opposite side of the street was perfectly clean. Strong winds are the most potent factor in the spread of the fly; there is no saying how far she may be carried."

The conditions existing in South Africa are entirely different from those in Honolulu and the outskirts of this city where our experiments on the flight of the marked Mediterranean fruit flies were performed. There are only a very few small orchards in and around the city of Honolulu but in practically every dooryard surrounding a residence a great variety of fruits are grown such as various kinds of citrus fruits, coffee, figs, garden varieties and wild guavas, mangoes, papaias, peach, plum, rose apple, tropical almond (umbrella tree or "kamani" nuts) sour sop, star apple, etc., from which we have bred the pest. These cultivated fruits ripen at different times of the year and offer the insect a regular succession of fruits in which to breed. In the uncultivated as well as in the mountainous districts of Honolulu the prickly pear which is also attacked by the fly is scattered over large areas. Different species of wild guaves which are hosts of the pest cover thousands and thousands of acres on the slopes of the mountains, in the gulches, in uncultivated portions of the valleys and plains, along the banks of streams and along some of the roads and paths leading from the city. These different species of wild guavas bear fruit practically the year around. Other wild fruits which the insect attacks are the mountain apples and the wild coffee berries. The climatic conditions in the Hawaiian Islands are also very favorable for the development of this trypetid, a generation of flies appearing about every four or five weeks throughout the year. In the city of Honolulu there is thus, a regular succession of cultivated fruit for the fruit fly to breed in, and in the outskirts of the city and in the mountainous districts wild fruits are available for the pest during the entire year.

In order to determine positively the powers of flight of the Mediterranean fruit fly, two thousand male specimens, which were bred in the laboratory from infested fruits, were handled and marked so that they would be injured as little as possible by employing the following methods: Hundreds of fruit flies were liberated under a small cheese-cloth tent which was fastened at its base to the three sides of a table and at its apex to the ceiling by a string. The head and shoulders were thrust under the tent at the open side and each specimen was captured in a small vial. The fly within the vial was seized by one wing with a pair of forceps, around the end of one prong a small elastic band had been wound. The fruit fly held by one wing,

was then placed upon a piece of white paper and usually in endeavoring to free itself, the fly would extend, spread and then catch hold of the paper with the legs on the opposite side of the body from the imprisoned wing, and attempt to pull its body away from the forceps. With the limbs in this position any leg on one side of the body could be easily cut through with either a sharp, spear-pointed or triangular-shaped needle, without danger of injuring the other appendages.

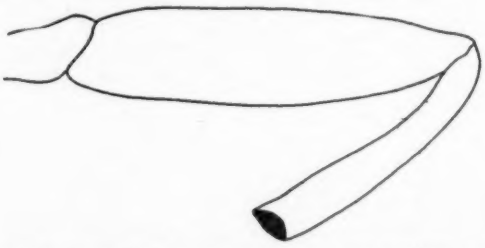


Fig. 1. Middle leg of Mediterranean fruit fly cut through the tibia. This specimen thus marked had been set free from the side of a mountain at an elevation of about three hundred fifty feet and was captured in a kerosene trap a mile and a half from the point of liberation.

After the amputation, the flies were put into breeding jars for a number of days to allow the wounded leg to heal. During this time they were fed with dilute molasses and water. The molasses was daubed on the sides of the jars by means of a camel's hair brush, while the water was sprayed into the jars in the form of a mist. The tops of the jars were covered with cheese cloth to allow free circulation of the air and the bottom of the jars were covered with sand to absorb the access of moisture and molasses.

The two thousand marked male flies were liberated on the outskirts of Honolulu in Manoa Valley which is walled in by mountains on all sides except the seaward side. This valley is more than two miles in length; in width, it varies from a half mile at the head end to a little more than a mile at its mouth, the greater portion of the valley being about three-quarters of a mile wide, (Pl. XXIX). The elevation of the mountains surrounding this valley varies from two thousand to two thousand five hundred feet at the head end but gradually becoming lower towards the mouth, (Pl. XXIX). At some places the sides of

the mountains rise very abruptly but in general the slope is quite gradual. The bottom of the valley consists largely of taro patches, (Pl. XXX).

At the head end of the valley, in a circle about a half mile in diameter, fifty kerosene traps were wired among the branches of citrus, fig, guava, hau and tropical almond trees. In a previous experiment we found that of every thousand Mediterranean fruit flies captured in kerosene only three were females and for this reason only marked males were used.

Fig. 2. Kerosene trap wired to a branch of a lemon tree. The white enameled pan containing the oil is covered with a galvanized iron cover to keep out the rain. The fruit flies enter the trap in the space between the cover and the rim of the pan.

The Mediterranean fruit flies were set free in lots containing from two to six hundred specimens. When the first lot of flies were set free, the jars containing the marked individuals were

held on a level with the eye to better enable the observer to note the direction of flight. In order to arouse the flies into activity and hasten their departure, the sides of the jars were snapped lightly with the fingers, with other lots, however, the jars were placed upon the ground and the males were allowed to escape. With the sky as a background, the unaided eye could follow the insects in their flight to a distance of about a hundred feet, but with the use of a field glass, the flies could be followed to a much greater distance.

While liberating the first lot of five hundred fruit flies in the center of the circle of traps it was observed that the wind played an important part in their direction of flight. A heavy north-east wind was blowing from the mountains to the sea, while these marked diptera were liberated, and it was striking to note that they flew and were carried with the wind down the valley with extreme rapidity towards the city of Honolulu. Since the prevailing winds at this time of the year are from the north-east, a change in the arrangement of the traps was made. The traps that had been located in that half of the circle nearest the head end of the valley, were placed amongst the trees of two citrus grooves, (Pl. XXX, 4), situated on the leeward side of the remaining semicircle of traps. (Pl. XXX, white line.)

The trypetids were liberated from three different points. As was already mentioned five hundred fruit flies with the hind leg cut, were liberated in the center of the circle of traps, about a half mile in diameter. After the traps had been rearranged a thousand specimens with the front leg severed were set free from the head end of the valley about a half mile from the traps. Five hundred males with the middle leg amputated were freed at the head end of the valley from the side of a mountain at an elevation of about three hundred fifty feet and at a distance of about one mile from the traps. A glance at the photograph shows the three points of liberation. (Pl. XXX, 1, 2, and 3).

The orientation of the marked individuals was carefully noted with the liberation of each lot of flies under the different climatic conditions. Whenever a heavy or light north-east wind blew from the mountains to the sea, the insects as soon as liberated would orient themselves with the wind and fly down the valley but when a south-west wind from the sea to the mountains prevailed, the specimens again oriented themselves

with the wind and in this case flew up the valley towards the mountains. In no case did the fruit flies attempt to orient themselves against even the lightest breeze. During calm spells no orientation took place and the flies darted off in all directions.

From time to time some of the kerosene traps were moved farther and farther into the city of Honolulu and were again hung among the branches of fruit bearing trees, usually citrus trees. These traps were visited every day, the fruit flies captured in a trap were put into a vial labeled as to the location of the trap. The kerosene was renewed daily in each trap.

The varying climatic conditions under which the different lots of flies were set free are indicated in the following table:

TABLE I.

Date	No. of Flies Liberated	Leg Cut	Conditions of weather at time of liberation		Total pptd. U. S. Weather Report
			Winds	Precipitation	
Feb. 21	500	Hind	Heavy N. E.	Frequent heavy rains	.72
24	600	Front	Light N. E.	Light rains, occasional heavy showers.	1.12
25	200	Front	Gusts of N. E. and Calm Spells	No rain.	.26
26	200	Front	Light N. E. and Calm Spells	No rain.	.21
29	500	Middle	Moderate S. W.	No rain.	.00

The total number of fruit flies captured during one month in the fifty kerosene traps was two thousand three hundred and nine, of this number one hundred fifteen were marked specimens from the two thousand that had been liberated. Of the marked individuals captured there were seventy-three with the front leg cut, eleven with the middle leg and thirty-one with the hind leg. Most of the one hundred fifteen marked insects were captured during the first fifteen days after the experiment had been started.

The first lot of five hundred Mediterranean fruit flies were set free during light rains followed by frequent heavy showers and yet thirty-one of these marked specimens were captured in the kerosene traps; apparently the drops of rain striking the fruit flies did not disable them for flight. The last lot of five hundred marked males was liberated while a south-west wind was blowing away from the city of Honolulu towards the mountains and yet eleven of these marked individuals were captured in kerosene traps located in the outskirts of the city at distances varying from a mile to a mile and a half from the point of liberation. The explanation of this fact may be that some of these marked insects were caught up by changes of wind carrying them first towards the mountains and then back again into the city of Honolulu.

Marked Mediterranean fruit flies were captured at distances varying from a quarter of a mile to a mile and a half from their respective points of liberation. In all probability some of the flies which had been set free during a strong wind were caught up and carried far into the city of Honolulu or even way beyond into the sea miles away from the points of liberation. In numerous instances kerosene traps were kept in the same tree for a period of two weeks and marked specimens were captured from time to time. The explanation of this fact may be that the fruit flies did not make one continuous flight from the point of liberation to the trap in which they were caught, or that the trypetids were not immediately attracted to the kerosene after getting into the vicinity of them.

On account of using male fruit flies only, the argument may be raised that there is no evidence from this experiment that the female flies are carried by the winds. How would the rapid distribution of the pest in the guava belt, often at high altitudes in the mountains, be explained? In all probability the answer to this question is best explained by the fact that the wind, which is such a potent factor in influencing the flight of the males, as demonstrated by this experiment, has carried the females as well as the males into the guava belt.

Clean culture to control the Mediterranean fruit fly as carried on by the Board of Agriculture in the Hawaiian Islands consists in stripping all fruit trees, except mangoes and papaias of infested and ripe fruit and also of picking up and destroying

fallen fruit. Attention has already been called to the fact that the wild guavas which are available for the pest to breed in during the entire year cover thousands and thousands of acres in the mountainous districts. If only a small per cent of the fruit flies breeding in these wild fruits are caught up by the winds blowing from the mountains towards the city of Honolulu, *what ultimate results can be expected from the clean culture methods of the present Mediterranean fruit fly campaign!*

After sending this manuscript to the editor we received from Dr. A. Berlèse a paper entitled, "Expériences Exécutées en Italie pour Combattre la Mouche des Oliviers." presented at "Ier Congrès International d'Oléiculture (Toulon, 1908)" in which he states that the olive fly, Dacus oleae Rossi obeys "l'instinct de diffusion, émigrent au loin, à la recherche de nouveau ambients.

En outre, dans la première génération printnaière-estivale l'instinct de migration se montre très développé chez les femelles. A cette époque l'on constate que certaines émigrations couvrent de grandes distances. Cela est éstrange, lorsqu'on pense a la commodité qu'auraient les mouches àdéposer, a cette époque, leurs oeufs là ou elles sont nées. Au contraire, elles vont parfois les pondre à plusieurs kilomèters (k—3,280.8 feet) de distance."

We are deeply indebted to Prof. Harry C. Severin, State Entomologist of South Dakota, who has given us valuable suggestions in reading the manuscript with us.

BIBLIOGRAPHY.

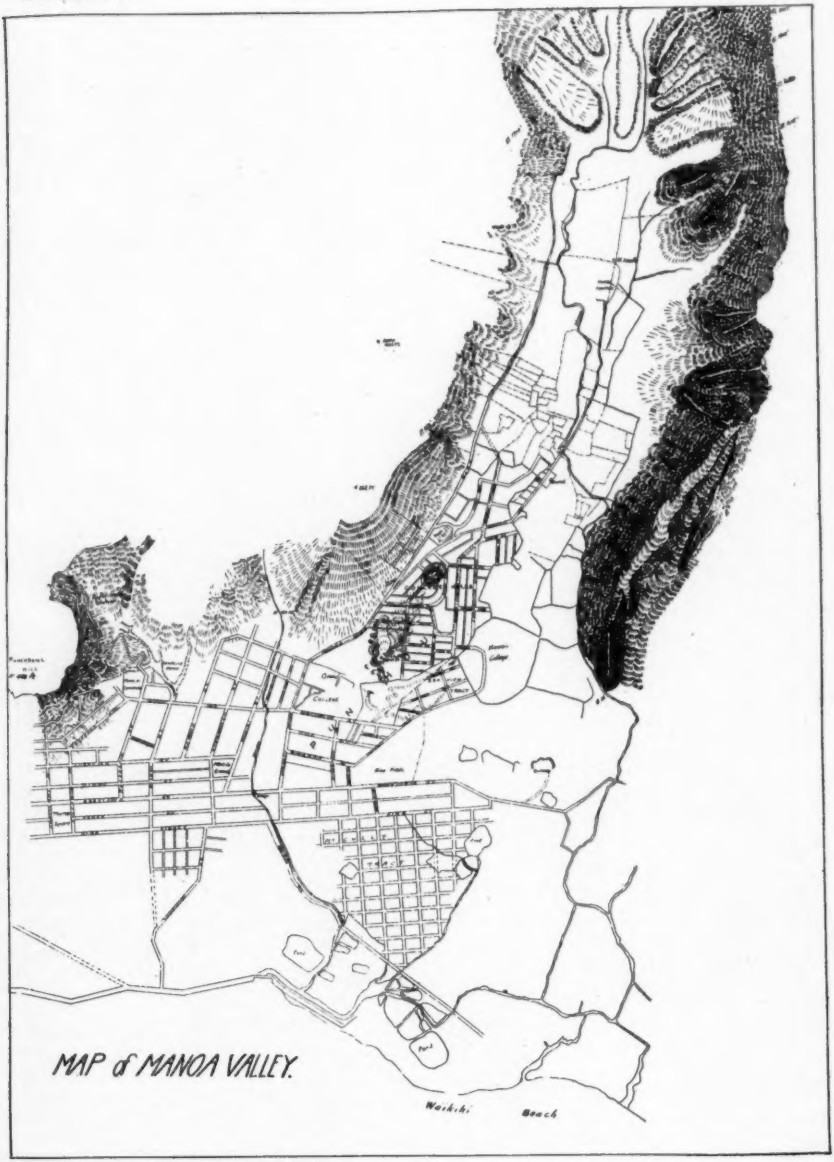
1. **Mally, C. W.**, 1904. The Fruit Fly (Ceratitis capitata, Wied.). Repr. Agric. Jour. Dec. No. 28, Cape of Good Hope. pp. 1–18.
2. **Newman, L. J.**, 1910. Fruit Fly. Dept. Agric. and Industries, Western Australia, Bull. 38, pp. 1–11.

EXPLANATION OF PLATE XXIX.

Map of Manoa Valley. This valley is walled in by mountains on all sides except the seaward side. The elevation of the mountains are indicated. The two thousand marked, male Mediterranean fruit flies were liberated at the head end of the valley.

EXPLANATION OF PLATE XXX.

Head end of Manoa Valley. Some of the fifty kerosene traps were wired among the branches of fruit trees situated along the white line. 1, 2, and 3 points of liberation of the two thousand marked, male Mediterranean fruit flies. 4, Citrus grooves. (Reproduced by permission of E. Bonine, photographer.)



H. P. Severin and W. J. Hartung.

HEAD END OF MANOA VALLEY.

Bonine, photo by permission.

Severin and Hartung.

OBSERVATIONS ON THE LIFE HISTORY OF A NEW SPECIES OF PSYCHODA.*

PAUL S. WELCH.

During the first three weeks of October, 1912, while engaged in certain biological investigations at the Chicago Sewage Testing Station, the writer's attention was attracted to a little white moth-like fly which occurred in great abundance in certain of the experimental tanks. An inspection of the form showed that it was one of the Psychodidæ belonging to the genus Psychoda. An examination was made of the rather extensive series of tanks and filters and it was found that these flies were confined to the immediate vicinity of the sprinkling filters and occurred in such great numbers as to indicate that not only were they breeding in or near the filters but that the environment must be a very favorable one. A survey of the animal life of the sludge of the sprinkling filters was being prosecuted at that time and the collections contained large quantities of a dipterous larva which when bred out produced the Psychodid fly. It was a very easy matter to rear this form and all the life history stages were observed. Furthermore collections from the filters often contained all of the life history stages from the egg to the adult.

In attempting to establish the identity of the adult it was found that it does not agree with any of the descriptions given for known species. It belongs to the group including *Ps. schizura* Kincaid, and *Ps. floridica* Haseman, which resemble each other in the mottled black and white character of the wings. However, this species possesses characters which differ distinctly from either of the above mentioned forms. After making careful comparisons with the descriptions of the species of Psychoda, the writer is convinced that this form must be regarded as a new species.

Psychoda albimaculata, n. sp.

Male: Smaller than the female; length of body (exclusive of extended genitalia) about 1.74 mm. Head and thorax yellowish gray, densely clothed with long, erect, mingled black and gray hairs. Abdomen white, covered thickly with erect white hair; very few dark hairs. Brush of gray hair, about one-fourth the length of the abdomen, extending caudad from the dorsal posterior edge of the thorax. Antennæ white;

*Contribution from the Entomological Laboratories of the University of Illinois, No. 33.

length equal to the width of the wings; 14 segments;[1] composed of spherical nodes joined by clear internodes; first segment cylindrical, the second spherical and distinctly larger than any of the other joints, and both the first and second segments with numerous fusiform scales as well as strong hairs; segments three to twelve inclusive with basal nodes and distal slender internodes; nodes with whorls of long white hair directed distad and projecting beyond the node of the adjacent distal segment; internodes clear, nodes slightly yellow; length of the internodes about the same length as the adjacent nodes; segment 13 bilobed, the basal lobe exceeding the other in diameter, separated by a broad shallow constriction, coating of hair similar to that of middle segments; segment 14 small and inconspicuous, about one-fifth the length of segment 13, with a few hairs and usually three or four terminal scales. Wings ovate, rather acutely angulated at tip of median vein, thick coating of hair on upper surface, moderate coating of hair on under surface; average length 2.1 mm., extremes of variation 1.74 to 2.28 mm.; average width 0.85 mm., extremes of variation 0.66 to 1.02 mm.; upper surface with distinctly mottled appearance, due to the presence of alternate patches of white and black erect hair; basal region of wing with black patches on or near veins III_1, III_2, V_3, VII_2; middle region of wing with black patches on or near veins III_1, III_2, III_4, V_1, V_2, VII_2; distinct tufts of black hair at the distal ends of veins III_1, III_2, III_4, V_1, V_2, VII_2; all intermediate spaces on surface between black patches occupied by white hair; rarely a very indistinct black tuft at distal end of V_2 and VII_1; fringe on anterior margin smoky, length about one-fifth the width of wing; posterior fringe smoky, length about one-fourth the width of wing; distinct tuft of long smoky hairs on costal margin at base of wing; hair on ventral surface of wing short, white, and nearly prostrate; cubital furcation nearer base of wing than tip. Legs white with slight tinge of yellow; extremities of distal segments of the tarsi tipped with brown; tibiæ and femora with scattering long black hairs, also some short prostrate black hairs intermingled with the white. Abdomen white, thickly clothed with long erect white hairs, originating on the posterior margin of each abdominal segment, thus producing a series of rings of erect hairs; black and gray hairs scanty. Inferior genital appendages of male prominent; length (including basis) 0.64 mm.; basis strongly developed, broad towards caudal extremity, with median conical projection, lateral margins converge towards base; inferior appendage expanding gradually towards basis; somewhat sigmoid in shape; heavy fringe of long white hair on caudal aspect; terminal spinule small, clavate. Superior genital appendages well developed; two segments; a little over one-third the length of the inferior genital appendages, proximal segment a little more strongly developed than the distal; with a few short whitish hairs. Intromittant organ slender.

1. Care must be taken in estimating the number of segments in this species since the thirteenth is of such a nature that an error can easily be made. The antennæ should be mounted so that the tip lies exactly in a plane at right angles to the objective of the microscope, otherwise the superimposed curved surfaces of adjacent parts produce appearances which easily lead to error.

Female: More robust than male; body slightly longer, and diameter of abdomen much larger. Head slightly yellowish, thickly set with white and gray hairs. Thorax white, densely clothed with white erect hairs; a few gray hairs present. Abdomen white, clad in white semi-prostrate hair. Antennæ white; two basal segments slightly yellowish; agree with the male in all other respects. Wings with average length of 2.58 mm., extremes of variation 2.28 to 3.06 mm.; average width 0.98 mm., variation from 0.90 to 1.14 mm.; otherwise like male. Legs with tarsal segments distinctly yellow, extreme tips dark; tibiæ and femora white with scattering black hairs, some long and others short. Ventral plate yellow; about as broad as long; emargination almost circular in outline. Ovipositor yellowish; almost straight.

Habitat: Chicago, Illinois. Described from 25 specimens, 10 males and 15 females.

In looking over the literature on *Psychodidæ* the writer was surprised to discover how little of it has to do with the life histories of the various species of this family. Forty-four species have been described from North America, and the life histories of only five are known. Kellogg (1901, p. 46) described briefly the life history of *Pericoma californica* Kincaid; Haseman (1907, p. 324) described the stages of *Psychoda floridica* Haseman; Fullaway (1907, p. 386) reported on the immature stages of *Psychoda schizura* Kincaid; and Haseman (1908, p. 274) described the life histories of *Psychoda nocturnala* Haseman and *Psychoda domestica* Haseman.

THE EGG.

(Fig. 3, Pl. XXXI.)

Eggs were easily obtained by confining females in stender dishes which contained a small quantity of sludge and water from the filter beds. Females were frequently put into the dishes in the evening and by the next morning clusters of eggs had been deposited. They were laid in masses on the bottom or sides of the dish or on fragments of rock which projected from the surface of the mass of sludge. Egg masses deposited in the dishes were never laid in the water, but just above the water and at the edges of moist areas on the bottom. These egg masses contained a varying number of eggs ranging from 20 to over 100. The masses were irregular in shape and the eggs which composed them were deposited in no definite order. They adhered strongly to the glass and were apparently cemented there at the time of oviposition. Under normal conditions the eggs are laid on the surfaces of the filter stone. It is very probable that eggs are not only deposited near the top surface of the

filter but at some depth since larvæ, pupæ, and adults were found two feet below the surface and it was evident that the adults encounter no difficulty in traversing the interstices.

The eggs are oval in shape and the majority show a slight concavity on one side accompanied by a corresponding convexity on the other, thus giving the eggs the appearance of being slightly bent in one plane. Sometimes this concavity is so reduced that this aspect of the egg is almost straight. A large number of eggs were measured, and it was found that they are quite constant in size. The length varied only from 0.32 mm. to 0.34 mm., and the measurements of the greatest diameter showed a variation of only 0.09 to 0.1 mm. The yolk is centrally located and comprises about one-half of the bulk of the egg. It is opaque, granular, and shows a homogeneous distribution in the freshly deposited egg. The substance outside the yolk is transparent and homogeneous. This substance is largely confined to the ends of the egg, and one end usually containing a larger quantity than the other. The outer egg membrane is smooth and transparent.

Development proceeds rather rapidly and in about sixteen hours after oviposition most of the eggs are in an advanced stage of development. Not all of the eggs of a given mass develop at the same rate, but some lag behind and therefore hatch later. The time between the laying and the hatching of the eggs was found to vary from about thirty-four to forty-eight hours.

THE LARVA.

(Fig. 6, Pl. XXXII.)

Larvæ in all stages of development occurred in great abundance in the sprinkling filter beds. The influents of these filters come from the settling and septic tanks and are thrown out into the air in a spray which falls on the surface of the filter bed and filters through about ten feet of crushed limestone. This influent carried considerable solid organic matter in suspension, some of which is retained in the filter. This sludge accumulates in some quantity on the surfaces of the stones and in the interstices formed by them, particularly in the upper part of the bed. The larvæ are found crawling through and over this sludge, and no doubt derive their food from it. Often larvæ may be found completely buried in the sludge with only the posterior breathing tube projecting into the air. They are active in their habits, and their characteristic crawling and wriggling form of locomotion is moderately efficient. They crawl with comparative ease over the surface of the filter rocks and even have the ability to crawl up the side of a glass vessel in which they may be confined.

At the time of hatching the larva is small, measuring only about 0.5 mm. It is whitish in appearance and quite transparent. It is active from the time of the emergence from the egg, and increase in size takes place rapidly. At this stage the two reddish-brown eye spots on the lateral aspect of the head are quite distinct. Immediately after hatching the little larva places itself, if possible, in a position which allows the breathing tube to be exposed to the air.

The mature larva is cylindrical, slender, and from 8.5 mm. to 9.5 mm. long. The greatest diameter, which occurs in the anterior region of the body, is about 1 mm. The color is light brown. In the mid abdominal region a whitish or silvery appearance is common and is in part due to the fact that the longitudinal tracheal trunks show through the integument to some extent. The body is composed of the head, three thoracic segments, and eight abdominal segments.

The head is much smaller than the adjacent thoracic segment. It is smooth, deep brown in color, and strongly chitinized. A pair of oval brown eye spots are present on the anterior lateral aspect. The head is to some extent retractile, and may be partially withdrawn into the thorax. The lateral margins of the clypeus converge posteriorly. Minute antennæ appear as a number of tiny rods of similar shape and size. The tip of the labrum is spiny and also bears a few setæ. The mouth parts, which are setose and denticulate, are enclosed in a sunken space on the anterior part of the ventral aspect of the head. On either side of the labrum and attached to the ventral surface is a pair of setose segmented appendages which in the living larva are in constant motion being rapidly extended and retracted and apparently serving as prehensile organs. Two pairs of clusters of setæ occur laterally, one pair near the eye spots and the other pair nearer the prothoracic segment. Setæ also occur on the dorsal aspect of the head, one aggregation located midway between the eye spots, two setæ near the middle, and two setæ near the caudal margin.

The thoracic segments are distinct and each shows one well marked constriction which divides it into an anterior and a posterior annulus. The posterior annulus of the prothoracic segment bears four groups of setæ (usually two in each group), two dorsal and two ventral. The ventral group usually has one long seta. The dorsal surface of the posterior prothoracic annulus bears two small brown protuberances, one on either side and dorso-lateral in position. The tip of each protuberance bears a closed spiracle which is the terminus of a branch of the tracheal system. The mesothorax and metathorax have one constriction each, and in other respects are similar to the prothorax, with the exception that the diameter is slightly increased. The thorax as a whole is smooth, and the fine chitinous surface spines are much smaller than those on the abdominal segments.

The first abdominal segment has one constriction, but the following six have two thus marking off each segment into an anterior, a median, and a posterior annulus. The setæ on the first segment are arranged as in the thoracic segments, while in the following segments ventral groups

occur on the anterior and posterior annuli of each. Two groups of setæ occur on the dorsal aspect of each posterior annulus. The entire surface of the first seven abdominal segments, excluding the intersegmental grooves and the constrictions, are thickly studded with fine brown chitinous spines. The eighth, ninth and tenth abdominal segments bear, on the dorsal surface, nine chitinous plates, one on each annulus. These plates are brown, heavily chitinized, and transversely elongated. They are not uniform either in size or shape, but in general the nearer the caudal region the larger do they become. The plates on segments nine and ten are approximately constant in size and shape in the different specimens, but in segment eight there is some variation. Usually three plates are present, but occasionally a specimen is found in which one may be very diminutive, or even entirely lacking. The plate on the posterior annulus shows the greatest variability. In exceptional cases it may be entirely absent, but the common form of the variation is in the size and shape. Judging from the predominance of the specimens showing it, the common form seems to be a central, somewhat quadrate plate with a small circular plate on either side. Other specimens may show the middle plate reduced to the size of the two small lateral ones. Still others show one of the lateral plates apparently fused with the central piece, and finally, specimens were examined in which the lateral plates were absent and the middle plate well developed. It seems probable that the latter has come about by the complete fusion of the two lateral plates to the median.

The terminal (eleventh) segment is smooth, heavily chitinized, and tapers caudad. The tip is emarginated. It bears two dorsal projections which show a few strong bristles; also two ventral projections, longer than the dorsal. Each of the four projections is armed at the extreme end with a crown of strong bristles. The anal opening is on the ventral side of segment eleven and near its base. The opening occurs on an anal papilla which is composed of four lobes. The region immediately surrounding the papilla is not chitinized, but close behind it is a lunate chitinous plate. Several long setæ occur near the papilla.

This larva differs distinctly from that of *Ps. schizura* in length and in diameter, in the number of chitinous plates on the dorsal posterior part of the abdomen, and in the presence of eye spots. It differs from the larva of *Ps. floridica* in the annulation of the body, in the number of setæ present and in the number of dorsal abdominal plates. The larva of *Ps. domestica* differs chiefly in the length and in the number of dorsal thoracic and abdominal plates. The larva of *Ps. nocturnala* differs principally in the form of the body and the number of dorsal abdominal plates.

THE PUPA.

(Figs. 1, 2, Pl. XXXI.)

The pupa rests on the sides of the filter stones, often completely surrounded by sludge with only the breathing tubes

exposed. It is rather sluggish and moves about slowly from place to place by means of a wriggling movement of the abdomen.

A large number of pupæ were measured and it was found that the average length exclusive of the respiratory tubes was 4.5 mm. The range of variation was from 4.02 mm. to 4.86. The greatest diameter which is in the region of the developing wings had an average length of 0.84 mm., the variation being 0.72 mm. to 0.9 mm. When first transformed the pupa is pale in color like the larva but soon becomes darker.

The head and thorax with their accompanying parts are usually deep brown. The thoracic respiratory tubes (Fig. 9, Pl. XXXII) are long and slender. Measurements show the average length to be 0.58 mm. and the extremes of variation from 0.54 mm. to 0.66 mm. Each consists of two parts, a short, yellow, indistinctly wrinkled, proximal stalk, and a much longer, dark, distal part. The latter has its maximum diameter at the base and tapers gradually towards the tip. Under magnification it shows a large number of fine transverse wrinkles. On the dorsal surface two approximately parallel rows of small clear circular spots extend from the base to the tip and there are aggregated into a small terminal cluster. According to Miall and Walker (1895, p. 146) these spots are the external openings of the large trachea which traverses the organ. Dell (1905, p. 303) however, has shown in *Psychoda sexpunctata*, a European species, that in places the tracheal extension bulges through the wall of the respiratory tube thus giving rise to the clear circular spots.

The abdomen is widest at its junction with the thorax and it gradually tapers caudad. The spines along the lateral margins are moderately developed and each normally ends in a fine stiff hair. The intersegmental grooves are both wide and deep, distinctly marking off the segments. Chitin is minimized in these intersegmental grooves and this accounts for the ability of the abdomen to perform rather active movements. These grooves are also much lighter in color than the contiguous parts thus giving the abdomen a banded appearance. The regions between the intersegmental grooves are strongly chitinized. Each bears an armature of spines on both the dorsal and ventral surfaces. On the former there is a single row of spines on the caudal margin of each segment while on the latter there are two rows on each segment, one near the middle of the segment and composed of large spines only, the other on the caudal margin of the segment and composed of large and small spines. Figures 1 and 2 show the number, comparative sizes, and disposal of these spines on the two surfaces. The examination of a large number of pupæ showed that the size and arrangement of these spines are constant and that there is only a very slight variation in the number, the variation being confined to the small spines. These small spines may be simple or compound (with double tips) and those on a given segment may vary to the amount of one or two in different specimens. The dorsal surface of the base of the last segment bears two simple laterally projecting spines and two similar spines occur on the ventral surface.

The caudal extremity of the last segment is laterally compressed and is equipped with two pairs of spines, one dorsal and the other ventral in position. The former is only moderately developed while the latter is strongly developed. The spines in both pairs diverge caudad and in each pair the component spines are separated by a distinct emargination.

This pupa differs from that of *Ps. schizura* in the length and diameter, in the number of abdominal spines, the character of the intersegmental grooves, and the character of the head region. It differs from the pupa of *Ps. floridica* chiefly in the character of the respiratory tubes and the number and arrangement of the abdominal spines. The pupa of *Ps. nocturnala* differs in the number of rows of spines on the first abdominal segment, and in size. The pupa of *Ps. domestica* differs markedly in the shape of the abdomen, in size and in the character of the abdominal spines.

Studies on the structure and activities of the different stages of this species are now in progress and the results will be published later.

The writer considered it unnecessary to give a complete bibliography of the literature on *Psychodidæ*. The following list includes only the papers referred to in the article.

LITERATURE CITED.

Dell, J. A. 1905. Structure and Life History of Psychoda sexpunctata. Transactions of the Entomological Society of London, pp. 293–311.

Fullaway, D. T. 1907. Immature Stages of a Psychodid Fly. Entomological News, Vol. XVIII, pp. 386–389.

Haseman, L. 1907. A Monograph on the North American Psychodidae, including ten new species and an Aquatic Psychodid from Florida. Transactions of the American Entomological Society, Vol. XXXIII, pp. 299–333.

1908. Notes on the Psychodidae. Entomological News, Vol. XIX, pp. 274–285.

Kellogg, V. L. 1901. An Aquatic Psychodid. Entomological News, Vol. XII, pp. 46–50.

Miall, L. C., and **Walker, N.** 1895. The Life History of Pericoma canescens. Transactions of the Entomological Society of London. pp. 141–147.

EXPLANATION OF PLATES.

PLATE XXXI.

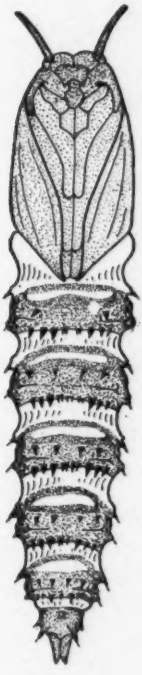
Psychoda albimaculata, n. sp.

Fig. 1. Dorsal view of the pupa.
Fig. 2. Ventral view of pupa.
Fig. 3. Eggs. Drawn shortly after oviposition.
Fig. 4. Basal joints of the antenna. Hairs and scales not shown.
Fig. 5. Distal joints of the antenna. Hairs and scales not shown.

PLATE XXXII.

Fig. 6. Dorsal view of the mature larva.
Fig. 7. Dorsal view of the male genitalia. Hairs not shown.
Fig. 8. Lateral view of the male genitalia. Hairs not shown.
Fig. 9. Dorsal view of one of the pupal respiratory tubes.
Fig. 10. Ventral plate of the female.
Fig. 11. Ovipositor.

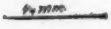
1



2

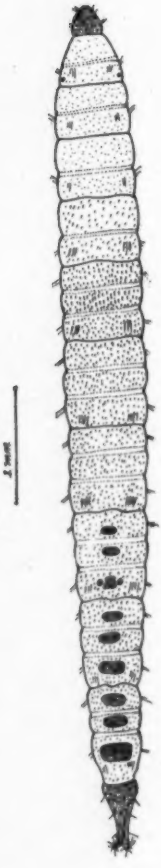
4

5

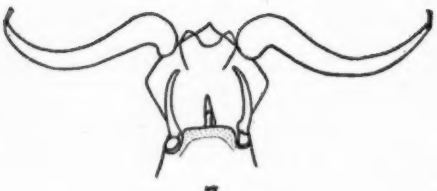


3

P. S. Welch.



6

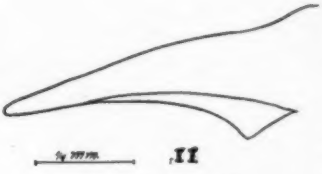


7

8

9

10



11

STOMOXYS CALCITRANS LINN.

CHAS. K. BRAIN, B. A., F. E. S., Entomologist.*

Stomoxys calcitrans Linn. has often been suspected of being an agent in the transmission of disease, and the recent experiments of Rosenau, Anderson and Frost seem to show conclusively that this insect can, and may, transmit Acute Poliomyelitis in animals—monkeys were used.

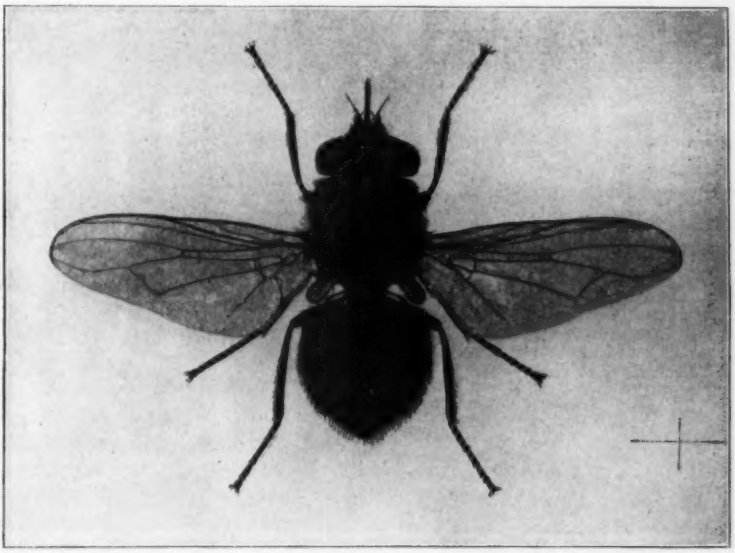


Fig. 1. Stomoxys calcitrans Linn. ♀. (After Austen.)

It is not said that *Stomoxys calcitrans* is the actual carrier of Infantile Paralysis in Nature, but its common occurrence in localities where the disease is most prevalent, and its ability to transmit the disease from sick to healthy animals, makes further study of the species desirable. Considerable mention has been made of this fly in the entomological literature of the last fifty years, chiefly in relation to its occurrence in stables, and various methods have been recommended for its destruc-

*This work was undertaken in connection with experimental work now being conducted by the Ohio State Board of Health, and the blocks used for the illustrations are the property of that Board.

tion, but, as far as I could ascertain, no work has been done in this country on its mouthparts and internal anatomy. Four papers in England and one of minor importance in France, which apply to this genus, if not to this particular species, are included in the Bibliography.

Facts relating to its life-history have been recorded by Packard and others, and Prof. James S. Hine of Ohio State University is at present working on this side of the subject. The writer made observations on its life-history in South Africa, and conducted feeding experiments in connection with the transmission of a Trypanosoma disease from Portuguese East Africa. When on this work it was noticed that very few *Stomoxys calcitrans* larvæ could be obtained from old, heating manure, but that, as a rule, perfectly fresh horse dung was chosen for oviposition. Where this was collected into heaps with stable refuse, and generated heat, nearly all the larvæ found in it were of *Musca domestica*. In rooms where food was kept the majority of flies were of the latter species, *Stomoxys calcitrans* being most prevalent in such places on dull, cool days. Counts were made of flies caught in the windows of two rooms of the Government Experiment Station at Rosebank, near Cape Town in 1910. In room A, the laboratory, over 40% of the flies caught in a week were *Stomoxys calcitrans*, while in room B, one of the living rooms, *Musca domestica*, comprised 93% of the flies caught, while *Stomoxys calcitrans* was rarely taken, representing less than 3% of the whole. The distance between the two rooms was approximately 35 feet. The three flies most common in houses, all of which have a very wide distribution, being almost universal, are *Musca domestica*, the House-Fly, *Homalomyia canicularis*, the Lesser House-Fly, and *Stomoxys calcitrans*, The Stable-Fly. The particulars given with the accompanying figures in Plate XXXIII will suffice for their identification in the various stages.

Musca domestica Linn. The House-Fly.

Egg: About 1 mm. long, elongate, cylindrical, oval, rather more pointed at the anterior end, dull chalky white in color. About 100 to 150 eggs laid in a mass in crevices in house refuse or accumulations of horse manure. Eggs hatch under favorable conditions in 8 to 24 hours.

Larva: 7 to 10 mm. long when full grown, greasy white in general color, except for the darker color of the contents of the alimentary tract. This larva can be distinguished from others by the shape and size of the plates which surround the posterior respiratory apertures.

These are situated on the broad end of the body and are close together, comparatively large, and circular except for the inside edges, which are straight. Under favorable conditions the larva is full grown and pupates in from 4 to 7 days. (See Fig. 2).

Pupa: Yellowish brown to dark reddish brown, barrel shaped, but tapering slightly towards the anterior end, 6 to 8 mm. long. (See Fig. 3.) Under most favorable conditions of temperature and humidity the pupal stage lasts 3 to 5 days.

Adult: The normal length is about 6 or 7 mm., mouse gray in color, while the thorax has four black, longitudinal stripes, which are usually most sharply defined in front. It may be noticed that the compound eyes more nearly meet on top of the head in the male than in the female. The proboscis, at rest, is not visible from above. The end of the 4th longitudinal vein bends sharply up so as to nearly join the vein above it. (See Fig. 1.) Females hibernate in winter. The House-Fly cannot bite and does not suck blood.

Homalomyia canicularis, Linn. The Lesser House-Fly.

Egg: This has not been studied by the writer but it is reported to be deposited in decaying animal and vegetable matter.

Larva: About 8 mm. long when full grown, brownish yellow in color and somewhat abruptly narrowed in front. This larva may readily be distinguished from that of *Musca domestica* or of *Stomoxys calcitrans* by the presence of spines shown in Fig. 5.

Pupa: The bristles of the last larval stage still persist in the pupa as does also the brownish coloration. The case is, however, somewhat shorter than the extended larva. (See Fig. 6.)

Adult: Normal length about 6 mm., but this fly is much more slender than the common house-fly. The thorax is blackish or dull grey, but the distinct longitudinal stripes are not noticeable in the ♂.

Front of head shining white in the ♂, while that of the ♀ is darkish grey. Width of vertex in the ♂ is one-seventh; in the ♀ one-third the total width of the head. ***The proboscis is not visible from above.*** End of 4th longitudinal vein not bent up towards the vein above but parallel to it. When this fly is at rest the tips of the wings are nearer together than in *Musca domestica*. This adds to the narrower and smaller appearance of the insect, and no doubt accounts, in some degree, for the common, but erroneous idea that these are young house-flies. Like the house-fly this species cannot bite and does not suck blood.

Stomoxys calcitrans Linn. The Stable Fly.

Egg: About 1 mm. long, white, elongate and banana-like in shape. One side straight, with a deep groove, the other curved. Laid in small masses of 40 to 70, in accumulation of moist and fermenting vegetable matter (straw, etc.), or in fresh horse manure. At favorable temperature the eggs hatch in 2 to 4 days.

Larva: Length when full grown about 10 mm., very similar in appearance and color to the larva of *Musca domestica*, but may be readily distinguished by the plates of the respiratory tubes which are dis-

tinctly smaller, circular, and from 4 to 6 times as far apart. (See Fig. 8.) Larval stage usually lasts 15 to 21 days, but may be extended under unfavorable conditions up to 80 days.

Pupa: Bright reddish brown to chestnut brown in color, and normally 6 mm. long; precisely similar to that of *Musca domestica* from which it may be distinguished by the plates in the same manner as the larva. In summer the adults usually emerge in 9 to 13 days after pupation. (See Fig. 9.)

Adult: Normal length about 7 mm., rather more robust in shape than either of the foregoing, darkish grey. Thorax with 4 conspicuous blackish longitudinal stripes. Abdomen without ochraceous-buff patches but dotted with clove-brown, the spots usually more conspicuous in the ♀. Vertex ¼ in ♂, and ⅓ in ♀ the width of the whole head. Proboscis shining black, projecting horizontally in front of the head, *visible from above* when not feeding. The end of the 4th longitudinal vein bent up, but not so much as in *Musca domestica*. (See Fig. 7.) A biting fly, *both sexes suck blood* from human beings as well as from cattle, horses, etc. Common about farmyards and stables, and common in houses near such places, especially on dull days. This accounts for the old saying in the country districts, that it is a sign of rain when the flies bite.

External Mouth Parts.

Unlike some of the other well known Blood-Sucking Diptera the male of this species feeds also on blood, and I have been unable to determine any difference between the mouth parts of the two sexes of *Stomoxys calcitrans*. The following description will therefore apply equally well to male or female. The external mouth-parts consist of maxillary palpi and the proboscis. (Plate XXXIV, Fig. 1. *mxp.* and *pr.*) Maxillæ proper and mandibles are not found, the proboscis consisting of the labrum, hypopharnyx and the labium.

The *maxillary palpi* consist of a single segment and are approximately one-fourth the length of the proboscis.

The *proboscis*, in a resting position, extends horizontally below the head and may be plainly seen projecting for about one-third of its length in front of the head. In this position its base is closely applied to the lower part of the head in the ventral groove, but when extended it will be observed that its attachment to the lower chitinous skeleton is membranous, except for the two strong apodemes. (*ap.* in Figs. 1, 2 and 4, Plate XXXIV.)

The *maxillary palpi* are attached to this membranous cone, and do not, in any part, enclose the proboscis. The proboscis is

somewhat longer than the height of the head, distinctly thickened, in the basal half, black, shining, and practically smooth.

The *labium*, or lower lip, is the strong black part referred to, and this constitutes the sheath for the labrum and hypopharynx. The labium consists of three segments. (Plate XXXIV, Fig. 1, *i*, *ii*, *iii*). Segment *i* is eight to ten times the length of the other two together. Segment *ii* is very small and inconspicuous, and segment *iii* is composed of the labella. Throughout the whole length of the labium is the dorsal groove, in which lie the labrum and hypopharynx. This dorsal groove is deep in the basal part and becomes gradually more and more shallow distally. Near the extreme base it is practically closed above by the overlapping of the dorsal margins of the labium. (Plate XXXIV, Fig. 3.)

The outer chitinous walls of the labium are comparatively thin but very hard, while the interior is completely filled by muscles and tracheæ. (Plate XXXIV, Fig. 3 *mc.* and *tr.*)

Segment *ii* of the labium, as has been said, is very small, and appears as a small section of chitin in the joint between *i* and *iii*. Segment *iii* is composed of the labella, fitting together as one might place the palms of the hands together with the fingers pointing forward. Around the margins of the labella, under low power, smaller and larger hair-like processes may be seen projecting, while if a labellum be removed and its inner surface examined under the microscope its structure will be found to be elaborate and interesting.

Figure 5 shows the inner surface of the right labellum, with its lower or ventral wall at *vw*, and the dorsal margin at *dm*. It will be seen that there are five strong chitinous teeth, *ct.*, and a series of chitinous blades, *cb.*, which are more delicate. In addition to these there are a number of longer or shorter setæ on the distal and ventral margins.

The Labrum (of Hansen) or upper lip, (*lb*, Figs. 2, 3 and 4) (=labrum-epipharynx of Newstead) reaches nearly to the base of the labella. Its shape in section is readily seen from Figure 3, *lb.*, where it will be noticed that its lateral margins are incurved below to form a definite tube with a rather broad slit. When feeding the tube is completed by the hypopharynx. (*hp.*, in Figs. 2, 3 and 4). The labrum is thickened at the base, is somewhat strongly chitinised, and has a sharp, flattened, tri-

angular, and highly chitinized point. At intervals along the inner surface, are sense organs, each with a short clear hair.

The Hypopharynx is as long as the labrum, and consists, until its distal end is neared, of a tube. (Fig. 3, *hp.*,) The apical part, however, is flattened and membranous, and quite unsuited for piercing.

Method of Feeding.

When about to feed *Stomoxys calcitrans* raises the body somewhat higher than the normal position on the legs, and brings the proboscis into practically a vertical position. The posterior part of the body is, in some cases, decidedly elevated. The tip of the proboscis is in this manner brought into contact with the skin of the host and the first puncture made. This, I believe, is performed by the labella, which are slightly parted so that the chitinous teeth and blades can be brought into operation. If blood emerges from the puncture it is sucked up, but if not I imagine the labella are depressed laterally and the point of the labrum forced into the host. I have observed on several occasions, when allowing *S. calcitrans* to bite, that there is often a decided stab after the first puncture had been completed.

The saliva is conducted to the wound by means of the hypopharynx, into the base of which the salivary duct opens. (*sd.*, in Figs. 2 and 4; *sc.*, Fig. 3.)

The blood is conveyed to the pharynx by means of the tube formed by the labrum and hypopharynx combined, which is in turn enclosed by the dorsal groove of the labium.

The pharynx proper has strongly chitinised walls, and powerful muscles, which make it well adapted for sucking.

Digestive System.

The relative position of the different parts of the alimentary canal in Stomoxys calcitrans are shown, in diagrammatic form, in Fig. 2. Beginning with the proboscis it will be seen to consist of the following parts: *l. hp.*, the canal formed by the labrum and hypopharynx combined. *g.*, the tube leading from this canal to the pharynx proper. *ph.*, the pharynx proper. *oe.*, the oesophagus, which passes through the brain at the point indicated. *pr.*, the proventriculus, from which two ducts pass backward, viz., *d. ss.*, the duct of the sucking stomach,

and the one dorsal to this, which is the thoracic intestine. *s. st.*, the sucking stomach. *in.*, the abdominal intestine. *m. t.*, the junction of the abdominal intestine and the proctodæum, at which point the Malpighian tubes enter. *r.*, the rectum. *a.*, the anus.

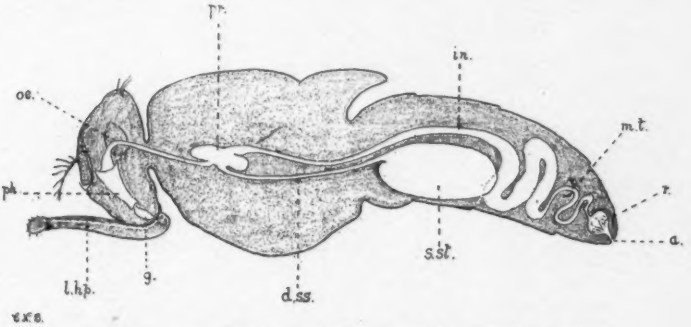


Fig. 2. *Stomoxys calcitrans* L. Semi-diagrammatic view of longitudinal section showing alimentary canal.

The food canal of the proboscis was described earlier in this paper, and this leads to a sausage-shaped tube, which has chitinous, and spirally thickened walls, and which is plainly seen in the membranous cone when the proboscis is extended for feeding. (Plate XXXIV, Figs. 2 and 4, *g.*) This, in turn, opens into the pharynx, which is roughly triangular in shape, having its upper edges drawn out into chitinous projections as muscle attachments. The œsophagus, on emerging from the pharynx, is wide and flattened, but soon becomes narrower and assumes a cylindrical form. It passes slightly forward and upward, turns abruptly backward through the brain and into the thorax, where it enters the ventral, anterior part of the proventriculus. The proventriculus is situated in the anterior third of the thorax, and, when seen from above, is a delicate white sac, circular in outline. It is roughly the shape of a mushroom, with its convex surface upward. The intestine arises from its posterior upper surface, while the œsophagus enters the ventral surface. Slightly posterior to this, again, on the ventral surface, the duct of the sucking stomach arises.

During its course through the thorax the intestine is practically of uniform thickness, but at about the point where it passes over the sucking stomach it becomes thicker, its walls,

at the same time, becoming thinner. The abdominal intestine is approximately three times the length of the fly. The thickened part, *i. e.*, that nearest the sucking stomach, is the only part coiled, and this lies in three simple, superposed coils, gradually narrowing to each end. Posterior to this the intestine continues, of practically uniform thickness, to the rectum.

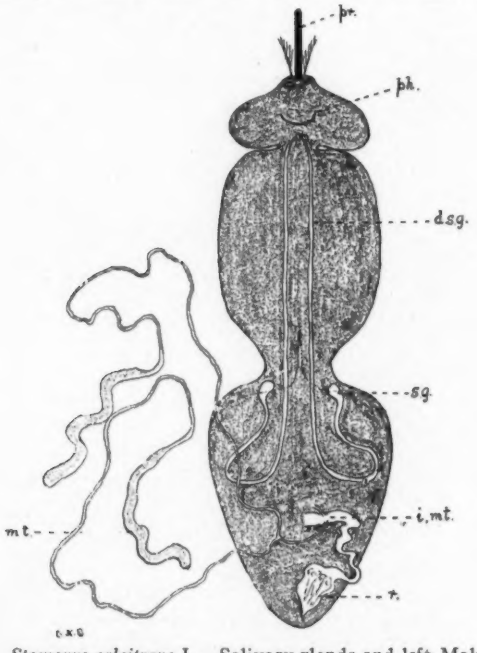


Fig. 3. *Stomoxys calcitrans* L. Salivary glands and left Malpighian tube (semi-diagrammatic).

The rectum is a transparent sac, cone-shaped, with the apex toward the anus. It contains four rectal glands, which are long and trumpet like in shape, and terminates in a narrow tube leading to the anus. The appendages of the alimentary canal are the sucking stomach, the salivary glands, and the Malpighian tubes.

The sucking stomach, when filled with blood, occupies the greater part of the abdomen, but when examined before the insect has fed, it lies in the anterior third, immediately above the salivary glands. Its walls are thin, being composed of a single layer of cells with interrupted strands of muscle fibre.

The salivary glands (Fig. 3, *s. g.*) are situated partly in the thorax, and partly in the abdomen. Their two ducts arise from the common salivary duct (Plate XXXIV, Figs. 2 and 4, *sd.*) in the head, and follow a parallel course through the thorax until the abdomen is reached. Here they become slightly wider apart, and then make a sharp turn outward and forward. Their extreme ends are slightly enlarged. Throughout their whole course they occupy a ventral position to the remainder of the alimentary canal.

The Malpighian tubes, *m. t.* in Fig. 3, are long, slender, and much coiled. They are readily seen in dissections, being easily distinguished by their opaque and yellowish appearance. They arise from the narrow, lower intestine, a single tube on each side. From each of these, in turn, two tubules branch, those of the left side only being indicated in the figure.

BIBLIOGRAPHY.

Hansen, H. J. Mouth parts of Glossina and Stomoxys, pp. 105–109 in the Monograph of Tsetse Flies by E. E. Austin, London, 1903.

Tulloch, F. M. G. The Internal Anatomy of Stomoxys. Proc. Roy. Soc. Lond. Ser. B., Vol. 77. 1905–6, pp. 523–531. Also in Jour. Army Med. Corps, Lond. Vol. 7. 1906. pp. 154–162. 5 Figs.

The species dealt with in this paper is not known, as Lieut. Tulloch states: "The dissections of the local variety of Stomoxys, which form the subject of this Note, were made at the suggestion of Prof. Minchin, during his direction of the Royal Society's Commission on Sleeping Sickness in Entebbe, Uganda. Lieutenant Tulloch describes the Digestive System, the Nervous System, the Circulatory System, and the ♂ and ♀ Generative Organs.

Giles, G. M. The Anatomy of the Biting Flies of the Genus Stomoxys and Glossina. Journ. Trop. Med. Lond. Vol. 9. 1906. pp. 99, 153, 169, 182, 198, 217, and 235. 1 Pl. and 36 Figs.

The parts dealing with the digestive tract, and the reproductive organs are taken mainly from Tulloch and Minchin, whose figures are reproduced.

Stephens, J. W. W., and **Newstead, R.** The Anatomy of the Proboscis of Biting Flies Ann. Trop. Med. & Parasitol. Liverpool, Vol. 1. 1907. pp. 171–198. 8 pls.

Surcouf, J., and **Picard, F.** Note sur les diptères du genre Stomoxys en Abyssinie Bull. Soc. Path. Exot., Par. Vol. 1, 1908. pp. 195–198.

This paper deals with the Genus Stomoxys in general but the following particulars are given on the mouth parts:

"Appareil buccal: L'appareil buccal est réduit; il se compose en dessus, d'un labre triangulaire, tranchant sur les bords et limitant une cavité ou se trouve la langue ou hypopharynx, non piquante et percée d'un canal en son milieu.

"La lèvre inférieure, tranchante, faite en forme de gouge, pénètre dans les tissus et forme le dessous. Cette lèvre inférieuer porte deux prolongements nommés paraglosses, qui sont hérissés de grosses épines tactiles. Elle porte les palpes près de sa base, et, au repos, sert à envelopper la langue."

DESCRIPTION OF PLATES.

PLATE XXXIII.

Figs. 1—9 after drawings by Terzi in Reports to Local Gov. Bd. on Public Health, N. S. No. 5. 1909. London.

Fig. 1. Musca domestica Linn., perfect insect.
Fig. 2. Musca domestica Larva.
Fig. 3. Musca domestica Pupa.
Fig. 4. Homalomyia canicularis, Linn., perfect insect.
Fig. 5. Homalomyia canicularis, Larva.
Fig. 6. Homalomyia canicularis Pupa.
Fig. 7. Stomoxys calcitrans Linn., perfect insect.
Fig. 8. Stomoxys calcitrans Larva.
Fig. 9. Stomoxys calcitrans Pupa.

N. B.—All figures are 4 times natural size.

PLATE XXXIV.

External mouth parts of Stomoxys calcitrans Linn.

Fig. 1. Median longitudinal section of skeleton of front of head showing antennae, maxillary palpi and proboscis; v, vertex; ant., antenna; ar., arista; mxp., left maxillary palpus; ap., apodeme; pr., proboscis; I, II, III, segments of labium; III, showing left labellum.

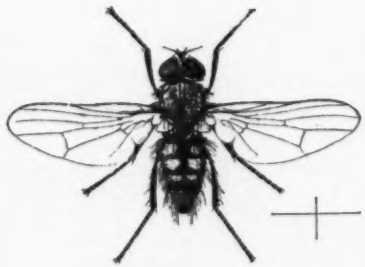
Fig. 2. Proboscis with labium removed; ap., apodeme; ph., pharynx; sd., salivary duct; g., lower part of oesophagus connecting the food canal of proboscis with the pharynx; I, portion of base of labium; lb., labrum; h. p., hypopharynx.

Fig. 3. Transverse section of base of proboscis. I outer wall of base of Segment I of labium; m. c., muscle cells; lb., section of labrum; h. p., section of hypopharynx; fc., food canal formed by labrum and hypopharynx combined; s. c., salivary canal of hypopharynx; tr., trachea; k., keel of chitin which gives rigidity to the base of labial groove.

Fig. 4. Base of proboscis with labium removed (adapted from Hansen's fig.); m., right muscle of enlargement of salivary duct s. d.; ph., pharynx; g., tube leading to pharynx; ap., base of apodeme.; lb., labrum; h. p., hypopharynx; b. h. p., base of hypopharynx; k, part of keel; see Fig. 3.

Fig. 5. Inner surface of right labellum; vw., ventral wall; d. m., dorsal margin; ct., chitinous teeth; cb., chitinous blades; h., hair-like processes (adapted from Hansen's fig.).

1.



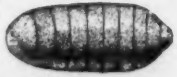
4.

7.

2.

5.

8.

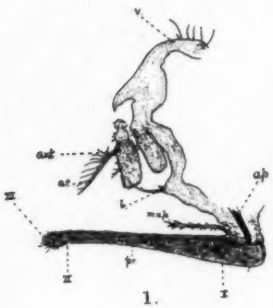


3

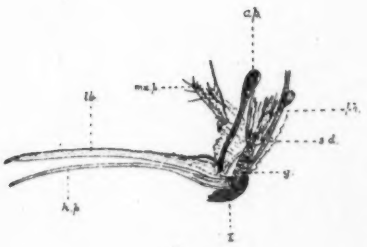
6.

9.

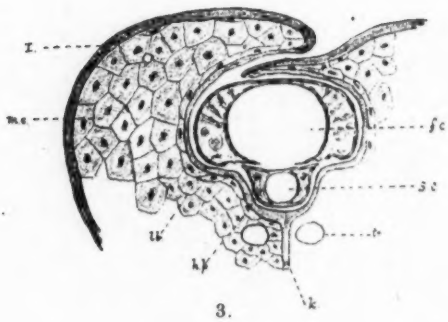
C. K. Brain.



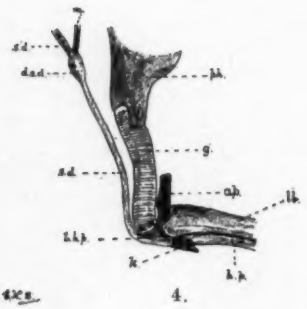
1.



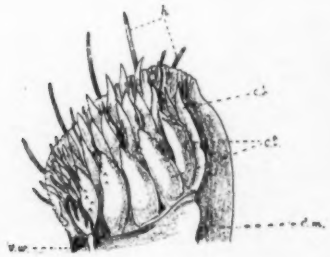
2.



3.



4.



5.

C. K. Brain.

INDEX OF VOLUME V.

abunensis, Iphiaulax, 220.
aciculatus, Pezomachus, 136.
acutipleura, Tipula, 42.
Aeschnidæ, 278.
Agelena nævia, 4.
Agriotypus armatus, 65, 70.
alaope, Cerceris, 22.
albifasciata, Tipula, 344.
albimacula, Tipula, 51.
albovittata, Tipula, 61.
Alexander, C. P., article by, 343.
alta, Tipula, 44.
Amaurobius, 7.
amazonica, Microtipula, 361.
americana, Ranatra, 281.
americanum, Lethocerus, 281.
americanus, Pezomachus, 137.
americanus, Theroscopus, 114.
Amnicola, 278.
amoena, Scolia, 317.
ampla, Cerceris, 16.
Anagrus subfuscus, 65, 70.
Anatomy of Icerya purchasi, 383.
Anax, 278.
  junius, 278.
anceps, Scolia, 338.
Andrena, 236.
annularis, Pomoxis, 276.
annulatum, Micromeson, 137, 139.
annulatus, Pezomachus, 137.
Aphredoderus sayanus, 276.
apiculata, Nepa, 281.
Apis, 236.
Apis mellifica, 234.
Apterophygus, 113, 114.
Aptesis, 113, 114.
Aquatic Hymenoptera in America, 65.
aquatica, Prestwichia, 70.
aquivolans, Hydrophylax, 65, 70.
arelate, Cerceris, 18.
Arenobius, 141.
  coloradanus, 141.
  mississippiensis, 144.
  sontus, 143.
Ariadna bicolor, 3.
apterogyne, Tipula, 344.
armatipennis, Tipula, 347.
armatus, Agriotypus, 65, 70.
ashmeadii, Pezomachus, 119, 120, 135.
aspersa, Tipula, 51.
Asynacta, 65.
atacama, Tipula, 357.
atrisumma, Tipula, 42.
Atypus, 3.
Augochlora, 237.
auripes, Pezomachus, 134.
aymara, Tipula, 353.
badia, Triscolia, 314.
bakeri, Rhogas, 221.
Banks, Nathan, article by, 11.
Bartlett, O. C., article by, 293.
Belostoma, 277.
Benacus griseus, 281.
biarmata, Tipula, 55.
bicincta, Scolia, 316.
bicolor, Ariadna, 3.
bicolor, Eucystomastax, 223.
bicornuta, Cerceris, 16.
bidens, Scolia, 338.
bidentata, Cerceris, 16.
bifalcata, Tipula, 55.
bifasciata, Scolia, 338.
bifasciatus, Rhogas, 222.
bilineatum, Ophion, 232.
Binarea, 209, 211.
Binarea calida, 209.
  spinicollis, 210.
biuncus, Tipula, 58.
Bombus, 234, 236.
Bombus terricola, 233.
bonikus, Polydesmus, 168.
Bracon,
  crassitarsis, 213.
  paræensis, 212.
  thalessiformis, 215.
Braconidæ, Brazilian, 193.
Bradley, J. C., Venation, 78.
Brain, C. K., article by, 179, 421.
Branner, J. C., 193.
branneri, Megaplectes, 195.
brasiliensis, Chelonus, 206.
brasiliensis, Crypturopsis, 198.
brasiliensis, Helorimorpha, 204.
brasiliensis, Mirax, 205.
Brazilian Ichneumonidæ and Braconidæ, 193.
brevistylus, Pezomachus, 119.
Bruchus, 377.
  chinensis, 377.
bruesii, Pezomachus, 136.
Brues, C. T., article by, 193.
Buwatia, 159.
  monterea, 159.
By-Laws, IX.

calcitrans, Stomoxys, 421, 423.
calida, Binarea, 209.
californica, Tipula, 49.
Campanotus, 236.
canicularis, Homalomyia, 423.
capensis, Pseudococcus, 182.
capitata, Ceratitis, 400.
carapunæ, Iphiaulax, 219.
Caraphractus cinctus, 68, 70.

catawba, Cerceris, 25.
cenocœlius tricolor, 208.
cervulus nodicornis, 212.
Ceratitis Capitata, 400.
Cerceris, Notes on the Eastern Species of, 11.
Cerceris
  alaope, 22.
  ampla, 16.
  arelate, 18.
  bicornuta, 16.
  blakei, 26.
  catawba, 25.
  chryssipe, 18.
  clymene, 20.
  clypeata, 18.
  compacta, 17.
  compar, 25.
  dentifrons, 18.
  deserta, 18, 22.
  fasciola, 23.
  finitima, 27.
  finitima nigroris, 27.
  firma, 20.
  frontata, 16.
  fulvipediculata, 24.
  fumipennis, 17.
  gnara, 22.
  halone, 24.
  imitatoria. 20.
  insolita, 23.
  irene, 26.
  jucunda, 26.
  juncunda carolina, 26.
  kennicotti, 25.
  nigrescens, 20.
  mandibularis, 17.
  morata, 19.
  prominens, 19.
  psamathe, 21.
  robertsoni, 17.
  rufinoda, 26.
  zelica, 23.
cetepurange, Tetragonochora, 194.
Chamberlin, R. V., article by, 141.
Change of names of Tipula, 61.
Chelonus brasiliensis, 206.
chilensis, Macromastix, 344.
Chilopods and Diplopods, New North American, 141.
chinensis, Bruchus, 377.
Chorebus natator, 70.
chryssipe, Cerceris, 18.
cinctus, Caraphractus, 68, 70.
citri, Pseudococcus, 178.
clara, Tipula, 61.
clymene, Cerceris, 20.
clypeata, Cerceris, 18.
cockerelli, Pezomachus, 123.
coloradanus, Arenobius, 141.
coloradensis, Pezomachus, 122.
commiscibilis, Tipula, 61.
communis, Linyphia, 4.
compacta, Cerceris, 17.
compar, Cerceris, 25.
Comstock, J. H. ,article by, 1.
concinna, Tipula, 61.
Conotrachalus nenuphr, Death feigning, 391.
consors, Scolia, 317.
Constitution, VII.
contaminata, Tipula, 61.
convergens Cerceris, 21.
cornigerum, Glyptocranium, 2.
Cosilidæ, 311.
Courtship of Trogoderma, 374.
crassitarsis, Bracon, 213.
crassus, Mesostenoideus, 197.
craveri, Tipula, 344.
Cremnodes, 113, 114.
cressonii, Pezomachus, 136.
Crosby, C. R., and Matheson, Robert, article by, 65.
Cryptanura hyalina, 201.
Cryptopyge obtusa, 194.
Crypturopsis, 198.
  brasiliensis, 198.
  minor, 199.
  striata, 201.
  uniformis, 200.
Cryptus heathi, 196.
cubensis, Scolia, 318.
Curtis, C. F., article by, 273.
cylindrata, Tipula, 46.
Cyclosa, 9.
Cystomastax, 223.

Dacnusa rousseaui, 70.
Damages of Trogoderma, 369,
Death feigning Conotrachelus nenuphar, 391.
Death Feigning Instinct in Heptagenia, 37.
dentifrons, Cerceris, 18.
derbyi, Tipula, 47.
deserta, Cerceris, 18, 22.
devorans, Lithobius, 147.
Dictyna foliacea, 6.
  sublata, 7.
  volucripes, 6.
differentialis, Melanoplus, 231.
Diplopods and Chilopods, New North American, 141.
dispar, Pezomachus, 125.
Distribution of Trogoderma, 369.
Doane, R. W., article by, 41.
Dolerus, 232.
Dolerus unicolor, 232.
domestica, Musca, 422.
Dragon-fly Nymphs, Observations on the Ecology of, 273.
dubia dubia, Scolia, 318.

dubia hæmatodes, Scolia, 320.
dubitatus, Heterospilus, 226.

edwardsi, Tipula, 344.
Elidinæ, 311.
Entomology, Faunistic Studies, 63.
Epicordulia, 278.
Erax, 244.
Eucystomastax, 223.
  bicolor, 223.
excisus, Iphiaulax, 217.

fasciiventris, Heterospilus, 224.
fasciola, Cerceris, 23.
Faunistic Studies in Entomology, 63.
Feeding of Trogoderma, 375.
Felt, numerals in classification, 76.
  Biology of miastor oligarces, 87.
ferruginosus, Pezomachus, 136.
fervida, Triscolia, 315.
Field, W. L. W., Hybrid Butterflies, 87.
Filistata, 7.
firma, Cerceris, 20.
fisheri, Helorimorpha, 205.
flavescens, Perca, 276.
flavicoma, Tipula, 57.
flavocauda, Tipula, 60.
flavocinctus, Pezomachus, 113, 129.
flavocostalis, Scolia, 321.
flavomarginata, Tipula, 46.
Flight of Insects, A Problem in the, 61.
foersteri, Pezomachus, 136.
foliacea, Dictyna, 6.
Food and Feeding in Heptagenia, 33.
fortis, Iphiaulax, 216.
Fossil May-flies, 102.
fragilis, Pseudococcus, 186.
frontata, Cerceris, 16.
fulvilineata, Tipula, 61.
fulvinodus, Tipula, 45.
fulvipes, 24.
fulvipediculata, Cerceris, 24.
fulviventris, Scolia, 323.
fumipennis, Cerceris, 17.
fumipennis, Tipula, 359.
fuscipennis, Scolia, 324.

garius, Paraiulus, 167.
Gee and Wilson, article by, 391.
gerriphagus, Limnodytes, 67, 68, 70.
geronimor, Soniphilus, 158.
Gerris, remigis, 67.
gibbosus, Lepomis, 276.
Glyptocranium cornigerum, 2.
gnara, Cerceris, 22.
Gosibius, 146.
  monicus, 146.
gracilis, Pezomachus, 136.
graphica, Tipula, 61.
griseus, Benacus, 281.
guato, Tipula, 349.
guttata azteca, Scolia, 326.
guttata guttata, Scolia, 325.
Gyrocampa stagnalis, 65, 70.

Habitat and General Habits in Heptagenia, 31.
halone, Cerceris, 24.
Hartung and Severin, article by, 400.
Haseman, L., Entomology in Missouri, 87.
heathi, Cryptus, 196.
hebes, cerceris, 16.
hecate, Scolia, 325.
Helorimorpha
  brasiliensis, 204.
  fisheri, 205.
Hemimachus, 113, 114.
Hemiteles, 114.
Hepialus, 234.
  humuli, 243.
  thule, 244.
Hepialus Thule, The Pupal Wings of, 239.
Heptagenia interpunctata Say, 37.
Heterogamus, 222.
Heterospilus
  dubitatus, 226.
  fasciiventris, 224.
  meridionalis, 225, 226.
  nigrescens, 226.
histrio, Polycyrtus, 201.
Homalomyia canicularis, 423.
Homologies in the Wing-Veins of May-flies, 89.
humuli, Hepialus, 242.
hyalina, Cryptanura, 201.
Hydrophylax, 66.
  aquivolans, 65, 70.
Hymenoptera, Aquatic, in America, 65.
Hymenoptera, Lacinia in the Maxilla of, 231.
Hyptiotes, 8.
Hypochilus, thorellii 7.

Icerya, purchasi, 383.
Ichneumonidæ, Brazilian, 193.
Idiasta nigripennis, 227.
iginus, Poabius, 153.
imitatoria, Cerceris, 20.
incurva, Tipula, 43.
infuscata, Macroxyela, 231.
Interpunctata Heptagenia, Natural History and General Behavior of, 31.
Iphialax, 216.
  abunensis, 220.
  carapunæ, 219.
  excisus, 220.
  fortis, 217.
  polybothris, 219.
  reduvioides, 216.

semialbus, 217.
starksi, 218.
tristis, 217.
xantothorax, 213.
inca, Tipula, 351.
inclusum, Trogoderma, 367.
inconstans, Scolia, 327.
Insects, A Problem in the Flight of, 61.
insignipes, Rhogas, 221.
insolens, Pezomachus, 136.
insolita, Cerceris, 23.
insularis, Pezomachus, 136.
interpunctella, Plodia, 377.
Ischnura, 65.

Johnston, C. E., article by, 383.
Johnson, C. W., color in types, etc., 86.
junius, Anax, 278.

kekakensis, Pezomachus, 137.
kennicotti, Cerceris, 25.
Kethops, 154.
utahensis, 155.
kirkaldyi, Ranatra, 281.
kukankensis, Pezomachus, 137.
kukakensis, Theroscopus, 114.

Lachnosterna, 370.
Lacinia in the Maxilla of Hymenoptera, 231.
latzeli, Lithobius, 152.
lecontei, Scolia, 329.
Lepomis gibbosus, 276.
Leptis, 244.
Lethocerus americanum, 281.
Liaconsine, 311.
Limnodytes
gerriphagus, 67.
setosus, 70.
Linyphia, 4.
communis, 4.
marginata, 4.
phrygiana, 4.
pusilla, 4.
Lithobius, 147.
devorans, 147.
voracior, 150.
longipes, Pezomachus, 123.
longispinus, Pseudococcus, 177.
longistylus, Pezomachus, 120.
lounsburyi, Pseudococcus, 179.
Ludvigia palustris, 68.
lymense, Micromeson, 138.
lymensis, Pezomachus, 137.

macrosticta, Cerceris, 16.
Macroxyela, 232.
infuscata, 231.
MacGillivray, A. D., article by, 231,239
Macromastix, 344.
chilensis, 344.
macrosterna, Pachyrhina, 344.
maculata, Vespa, 232.
maculatus, Pezomachus, 121.
maculithorax, Ophiogastrella, 202.
mandibularis, Cerceris, 17.
manni, Ophionellus, 203.
manni, Parabinarea, 211.
manni, Pezomachus, 132.
marginata, Linyphia, 4.
marina, Tipula, 44.
Matheson, Robert, and C. R. Crosby, article by, 65.
Mating of Trogoderma, 374.
maya, Tipula, 358.
May-flies, Homologies in the Wing-veins, 89.
May-fly tracheation, Peculiarties of, 93.
Mediterranean Fruit Fly, 400.
Megaplectes branneri, 195.
Melanoplus differentialis, 231.
mellifica, Apis, 234.
mellitor, Microbracon, 213.
Membership of the Society, X.
meridiana, Tipula, 58.
meridionalis, Heterospilus, 225, 226.
Mesostenoideus crasuss, 197.
Metepeira, 9.
mexicana Cerceris, 17.
mexicana, Scolia, 338.
micariæ, Pezomachus, 120.
Microbracon mellitor, 213.
microcephala, Tipula, 344.
Microcryptus, 114.
Micromeson, 137.
annulatum, 137, 139.
lymense, 138.
Microtipula, 360.
amazonica, 361.
minor, Crypturopsis, 199.
minutus, Pezomachus, 119.
Mirax brasiliensis, 205.
mississippiensis, Arenobius, 144.
mohavea, Scolopendra, 156.
monicus, Gosibius, 146.
monifera, Tipula, 344.
moniformis, Tipula, 344.
monterea, Buwatia, 159.
monticola, Scolia, 330.
morata, Cerceris, 19.
mordax Lithobius, 152.
Morgan, May-fly photographs, 77.
Morgan, Anna H., article by, 89.
Moulting and Life Cycle in Heptagenia, 38.
Moulting of Trogoderma, 372.
muraltiæ, Pseudococcus, 184.
Musca domestica, 422.
Mutillidæ, 311.
Myrmosidæ, 311.
Myzinidæ, 311.

nævia, Agelena, 4.
nankus, Poabius, 153.
natans, Polynema, 65.
natator, Chorebus, 70.
nelson, abnormal queen bee, 78.
Nemasoma, 162.
  uta, 162.
Nepa, 277.
  apiculata, 281.
Nephila, 9, 10.
New Neotropical Tipuline, 343.
New Western Tipula, 41.
nigrellus, Pezomachus, 113, 121.
nigropennis, Idiasta, 227.
nigrescens, Cerceris, 20.
nigrescens, Heterospilus, 226.
nigrescens, 22, 23.
nigrocorporis, 45.
nigrofuscus, Pezomachus, 133.
nigrolutea, Pachyrhina, 344.
nobilitata, Scolia, 332.
nobilitata var. maculata, Scolia, 338.
nodicornis, Cervulus, 212.
nodosus, Pezomachus, 128.
Notonecta, 68.
novomexicana, 21.

obsesus, Pezomachus, 125, 136.
obsoleta, Cerceris, 23.
obtusa, Cryptopyge, 194.
occidentalis, Tipula, 59.
occipitomaculata, 22.
Officers for 1912, V.
olympia, Tipula, 61.
Ophiogastrella, 201.
  maculithorax, 202.
Ophion bilineatum, 232.
Ophionellus, 202.
  manni, 203.
Osborn, Herbert, article by, 61, 63.
otomita, Scolia, 333.
ottawænsis, Pezomachus, 134.

pacifica, Tipula, 48.
Pachyrhina, 344.
  macrosterna, 344.
  nigrolutea, 344.
  trinidadensis, 346.
palustris, Ludvigia, 68.
Pantarves, 244.
Parabinarea, 210.
  manni, 211.
parænsis, Bracon, 212.
Paraiulus, 163.
  garius, 167.
  timipius, 165.
  tivius, 163.
parishi, Tipula, 355.
pellucida, Tipula, 61.
pennsylvanicus, Pezomachus, 126.
pennsylvanicus, Sphex, 233.
Perca flavescens, 276.
Peterson, Alvah, article by, 237.
Pezolochus Forster, 113.
Pezomachus, Key to the Species of, 115.
Pezomachus, 114.
  aciculatus, 135.
  americanus, 137.
  annulatus, 137.
  ashmeadii, 119, 120, 135.
  auripes, 134.
  brevistylus, 119.
  bruesii, 136.
  cockerelli, 123.
  coloradensis, 122.
  cressonii, 136.
  dispar, 125.
  ferruginosus, 136.
  flavocinctus, 113, 129.
  foersteri, 136.
  gracilis, 136.
  insolens, 136.
  insularis, 136.
  kukakensis, 137.
  longipes, 123.
  longistylus, 120.
  lymensis, 137.
  maculatus, 121.
  manni, 132.
  micariæ, 120.
  minutus, 119.
  nigrellus, 113, 121.
  nigrofuscus, 133.
  nodosus, 128.
  obesus, 125, 136.
  ottawænsis, 134.
  pennsylvanicus, 126.
  robustus, 120.
  rufipes, 136.
  similis, 127.
  spiraculus, 124.
  stanfordensis, 123.
  texanus, 137.
  utahensis, 118.
Pezomachini, North American, 113.
Phanerotoma trivittata, 207.
Pholcus, 2, 4, 5.
Phototact reactions and Death Feigning of Trogoderma, 378.
phrygiana, Linyphia, 4.
Physa, 278.
planicornia, Tipula, 52.
Plodia, 377.
  interpunctella, 377.
Poabius, 153.
  iginus, 154.
  nankus, 153.
polybothris, Iphiaulax, 217.
Polycyrtus histrio, 201.
Polydesmus, 168.
  bonikus, 168.
Polynema natans, 65.

Pomoxis annularis, 276.
popofensis, Theroscopus, 114.
Prestwichia aquatica, 65, 70.
Priocnemis, 236.
Proceedings of Washington Meeting, 76.
prominens, Cerceris, 19.
Protoparce carolina, 237.
psamathe, Cerceris, 21.
Pseudanomalon, 201.
Pseudococcus of South Africa, 179.
Pseudococcus
  capensis, 182.
  citri, 178.
  fragilis, 186.
  lounsburyi, 179.
  longispinus, 177.
  muraltiæ, 184.
  wachendorfiæ, 183.
Psychoda, Observations on, 411.
Psychoda, 411.
  albimaculata, 411.
  californica, 413.
  domestica, 413–416.
  floridica, 411, 413, 416.
  nocturnala, 413, 416.
  psychoda, 413.
  schizura, 411, 416.
  sexpunctata, 417.
pungonius, Sozibius, 152.
Pupal Wings of Hepialus Thule, 239.
Pupation of Trogoderma, 374.
purchasi, Icerya, 383.
pusilla, Linyphia, 4.
pyramis, Tipula, 53.

Rahopalsomidæ, 311.
Ranatra, 277.
  americana, 281.
  kirkaldyi, 281.
reduvioides, Iphiaulax, 216.
remigis, Gerris, 67.
Report of the Committee on Nomenclature, 79.
  of Auditing Committee, 85.
  by Prof. T. D. A. Cockerell, 80.
  of the Committee on Resolutions, 80.
  of the Executive Committee, 81.
Resolutions
  On the Death of S. H. Scudder, 72.
  On the Death of H. C. McCook, 73.
  On the Death of D. W. Coquillett, 75.
Results on Starvation of the Larvæ of Trogoderma, 379.
Rhogas, 221, 223.
  bakeri, 222.
  bifasciatus, 222.
  insignipes, 221.
ridingsii, Scolia, 334.
robertsoni, Cerceris, 17.
robustus, Pezomachus, 120.
rousseaui, Dacnusa, 70.
rubostigmosa, Tipula, 344.
rufinoda, 12.
rufipes, Pezomachus, 136.
rufipes, Theroscopus, 114.
rufopicta, 12.
rupicola, Tipula, 50.
rusticola, Tipula, 47.

sayanus, Aphredoderus, 276.
Scolia, 315.
  amoena, 317.
  anceps, 318.
  atrata, 294.
  bicincta, 376.
  bidens, 338.
  bifasciata, 338.
  campestris, 294.
  consors, 317.
  cubensis, 318.
  dubia dubia, 318.
  dubia hæmatodes, 320.
  flavifrons, 294.
  flavoscostalis, 321.
  fulviventris, 323.
  fuscipennis, 324.
  guttata azteca, 326.
  guttata guttata, 325.
  hecate, 325.
  inconstans, 327.
  lecontei, 329.
  mexicana, 338.
  monticola, 330.
  nobilitata, 332.
  nobilitata var. maculata, 338.
  otomita, 333.
  quadripuncatata, 295.
  ridingsii, 334.
  tricincta, 322.
  vintschgaui, 336.
Scolopendra, 156.
  mohavea, 156.
semialbus, Iphiaulax, 217.
setosus, Limnodytes, 70.
Severin, H. H., article by, 76, 400.
sima, Tutsona, 161.
similis, Pezomachus, 127.
Smith Glycogen in Insects, 77.
smithi, Tipula, 350.
Soniphilus, 158.
  geronimor, 158.
sontus, Arenobius, 143.
Sozibius, 153.
  pungonius, 153.
spatha, Tipula, 59.
Sphex pennsylvanicus, 233.
Spiders, The Evolution of the Webs of, 1.
spinicollis, Binarea, 210.
spinipes, 152.
spinulatus, Thaumatotypus, 116.
spiraculus, Pezomachus, 124.

stagnalis, Gyrocampa, 70.
stanfordensis, Pezomachus, 123.
starksi, Iphiaulax, 218.
sternata, Tipula, 56.
Sthenopis, 242.
Stomoxys calcitrans, 421, 423.
striata, Crypturopsis, 201.
Strickland, E. H., article by, 113.
subandina, Tipula, 344.
subfuscus, Anagrus, 65, 70.
sublata, Dictyna, 7.
suprenans, 152.
sylvicola, Tipula, 53.

Tabanus, 244.
taibona, Xystockeir, 170.
tarsale, Trogoderma, 367.
Tegenaria, 4.
tepidariorium, Theridion, 5.
terricola, Bombus, 233.
Tetragonochora cetepurange, 194.
texanus, Pezomachus, 137.
thalessiformis, Bracon, 215.
Thaumatotypus, Forster 113.
  Key to the Species of, 115.
  spinulatus, 116.
Theridion tepidariorum, 5.
Theridiosoma, 8.
Theroscopus Forster, 113.
Theroscopus, 114.
  americanus, 114.
  kukakensis, 114.
  popofensis, 114.
  rufipes, 114.
Thigmotaxis in Heptagenia, 34.
thorellii, Hypochilus, 7.
thule, Hepialus, 239, 244.
timipius, Paraiulus, 165.
Tiphidæ, 311.
Thynnidæ, 311.
Tipula, Change of names. 61.
Tipula, New Western, 41.
Tipula
  acutipleura, 42.
  albifasciata, 344.
  albimacula, 51.
  albovittata, 61.
  alta, 44.
  apterogyne, 344.
  armatipennis, 347.
  aspersa, 51.
  atacama, 357.
  atrisumma, 42.
  aymara, 353.
  biarmata, 55.
  bifalcata, 55.
  biuncus, 58.
  californica, 49.
  clara, 61.
  commiscibilis, 61.
  concinna, 61.
  contaminata, 61.
  craveri, 344.
  cylindrata, 46.
  derbyi, 47.
  edwardsi, 344.
  flavicoma, 57.
  flavocàuda, 60.
  flavomarginata, 46.
  fulvinodus, 45.
  fulvilineata, 61.
  fumipennis, 359.
  graphica, 61.
  guato, 349.
  inca, 351.
  incurva, 43.
  marina, 44.
  maya, 358.
  meridiana, 58.
  microcephala, 344.
  monifera, 344.
  moniliformis, 344.
  nigrocorporis, 45.
  olympia, 61.
  occidentalis, 59.
  pacifica, 48.
  parishi, 355.
  pellucida, 61.
  planicornia, 52.
  pyramis, 53.
  rubostigmosa, 344.
  rupicola, 50.
  rusticola, 47.
  smithi, 350.
  spatha, 59.
  sternata, 56.
  sylvicola, 53.
  subandina, 344.
  tergata, 56.
  ungulata, 54.
  variinervis, 344.
  vittatapennis, 61.
Tipulidæ, 343.
Tipulinæ, New Typotropical, 343.
Tipulini, 343.
Titsona, 160.
  sima, 161.
tivius, Paraiulus, 163.
Tomato-Worm Larva, Anatomy of, 237.
Tracheæ, Costal and sub-costal, 93.
Trachea, Radial, 94.
  Medial, 95.
  Cubital, 99.
  Anal, 100.
tracheation, Peculiarities of May-fly, 93
transmarium, Lithobius, 152.
tricincta, Scolia, 322.
tricolor, Cenocoelius, 208.
trinidadensis, Pachyrhina, 344.]
Triscolia, 313.
  badia, 314.
  fervida, 315.

tristis, Iphiaulax, 217.
trivittata, Phanerotoma, 207.
Trogoderma, 367.
  tarsale, 367.
  inclusum, 367.
Tsou, Chinese wax scale, 77.
Tucker, Mistletoe Insects, 76.
tyrannus, 152.

Uloborus, 8.
ungulata, Tipula, 54.
unicolor, Dolerus, 232.
uniformis, Crypturopsis, 200.
uta, Nemasoma, 162.
utahensis, Kethops, 155.
utahensis, Pezomachus, 118.

Variation in Size of Trogoderma, 378.
variinervis, Tipula, 344.
verticalis, Ischnura, 65.
Vespa maculata, 232.
Vespoidea, 311.
vintschgaui, Scolia, 336.
vittatapennis, Tipula, 61.
volucripes, Dictyna, 6.
voracior, Lithobius, 147.
vorax Lithobius, 152.

wachendorfiæ, Pseudococcus, 183.
Wasps, Digger, 294.
Webster, F. M., Education of Entomologists, 86.
Welsh, Paul S., article by, 411.
Wilson and Gee article by 391.
Wodsedalek, J. E., article by, 31.

xantothorax, Iphiaulax, 213.
Xystockeir, 170.
  taibona, 170.

zelica, Cerceris, 23.